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EDITORIAL

REPORT OF THE COMMITTEE ON SOIL EROSION

THE Report of the Soil Erosion Committee has been in the hands of the public for some three months. Everyone interested in the agriculture of the Island has now had time to make himself acquainted with the situation as presented by the Committee. The problem now is very largely a personal one. What is each individual concerned in any way with the terrible state of affairs shown in the Report going himself to do? To prevent a continuation of such things as have been going on in the past is the plain duty of all concerned. The Committee has taken what seems to many to be very optimistic ideas of the powers of education. It thinks, that educative methods should be tried for a period of five or seven years before compulsion by legislation should be considered. *"Without deprecating the enormous significance of internal damage to the Island as a whole the Committee has decided that, until the possibilities of propaganda, persuasion, and example have been exhausted, it is not desirable to recommend Government interference with private property. The Committee considers, however, that after educative methods have been tried for a limited period, say five years, or if the present depression continues, seven years, the subject should be brought up for review on the understanding that, if conditions are still unsatisfactory, compulsion by means of legislation should be further considered."* Unfortunately educative methods do not by themselves always prove sufficient to enforce amongst men the control of plant pests and animal and human diseases of a virulent, and even infectious, type, and it is difficult to see why they should be expected to do so in this problem of soil erosion. The difficulty is all the more

so in that the dread of being oneself the subject of infection in the case of disease has itself an educative influence of a salutary nature. Fear as an educational method is a very powerful one in the human mind although perhaps not recommended by present-day psychologists. In the case of soil erosion no such educational influence is by itself to be looked for but rather the reverse, for soil erosion is often the result of the encouragement of hoped-for sordid gain. Everything that is best in human nature is therefore needed to encourage us to consider this problem from the standpoint of the Island's good. If the good sense of the planting community can be brought to cry, in large measure, a halt to soil erosion, it will greatly redound to its credit. It is to be hoped that all Planting Associations will give the fullest consideration to this Report by discussion at their meetings and precept on their estates. Every planter should consider it his duty to make himself thoroughly acquainted with it. The greatest assistance could come from Planters' Associations if they would constitute themselves as vigilance committees and call the attention of any erring members to soil erosion on their lands. The Report is circulated to all field officers of the Agricultural Department and their attention called to the necessity to do what they can to educate and direct the small-holder along lines of soil conservation. It is to be hoped that these and many other educative means may bear fruit, but they can only do so if the immensity and importance of the problem be realised and grappled with by all concerned. Let us see to it that this is the case.

A MANURIAL EXPERIMENT WITH CACAO

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A CACAO manurial experiment at Peradeniya was brought to a conclusion on March 31st, 1931.

The plan of the experiment was as follows:

Sixteen plots of approximately one acre each were used, and these were divided into four groups of four plots each, each group containing one plot of each treatment. Each plot was given a letter denoting the treatment, followed by the permanent number of the plot. The four treatments were:

A plots 250 lb. Superphosphate per plot per annum.

B ,, 100 lb. Muriate of Potash per plot per annum.

C ,, 250 lb. Superphosphate and 100 lb. Muriate of Potash per plot per annum.

D ,, (Control). No manures, but the same cultural treatment as the manured plots.

All manures were applied in the month of January each year and were lightly forked in with mamoty forks. The D plots received a similar light forking at the same time.

In each group the control plot (D plot) was not selected by randomisation but the plot which had given the highest average yield over the four years prior to the first application of the manures was taken.

Records were maintained of the wet weights of good and black cacao in each plot and these figures were converted into good dry and black dry weights at 38 per cent and 21 per cent respectively; these figures being the actual average out-turn in each grade over a period of six years. Conclusions were to be based on the average annual yields of the A, B, and C plots relative to the D plots without manures during the four cacao years 1923-24, 1924-25, 1925-26, and 1926-27, compared with the average annual yields of the A, B, and C plots relative to the D plots with manuring in the four cacao years 1927-28, 1928-29, 1929-30, and 1930-31. In other words, since the D plots were in each group the highest yielders in the first period it was intended to see whether the lead of the D plots over the A, B, and C plots was reduced by manuring the latter. In addition to yields, the intention was to study the effect of manuring on pod canker incidence by comparing the proportion which good cacao formed of the total crop in the two periods.

The total yields of good and black cacao will first be considered in tables I, II, and III. To avoid presenting a bewildering mass of figures, only the average yield of the four years in each period are shown. The yields of the four plots (one in each group) which have received the same treatment are shown together.

Table I

Yields of plots manured with 250 lb. of Superphosphate per acre per annum.

Plot	Average annual yield of dry cacao in unmanured period lb.	Percentage increase or decrease over control plot in same group	Average annual yield of dry cacao in manured period lb.	Percentage increase or decrease over control plot in same group	Difference of percentage increase or decrease over control plot in manured period compared with unmanured period
A5 (Group 1)	370	−13·6	351	−28 0	−14·4
A9 („ 2)	364	−23·2	410	− 9· 3	+13·9
A115 („ 3)	457	− 6·1	476	− 4· 6	+ 1·5
A9/ („ 4)	369	−30·6	511	−34· 2	− 3·6
Average	390	−18·4	437	−19· 0	− ·6

From these figures it would appear that although in two plots, A 9 and A 115, a reduction has been effected in the decrease over the control plot, in the other two plots, A 5 and A 91, the decrease has been further accentuated and the indication is that the application of superphosphate has on the average failed to improve the position of these plots relative to the control plots.

Table II

Yields of plots manured with 100 lb. Muriate of Potash per acre per annum.

Plot	Average annual yield of dry cacao in unmanured period lb.	Percentage increase or decrease over control plot in same group	Average annual yield of dry cacao in manured period lb.	Percentage increase or decrease over control plot in same group	Difference of percentage increase or decrease over control plot in manured period compared with unmanured period
B 4 (Group 1)	387	−13 6	304	−37·5	−23·9
B 95 („ 2)	405	−14·4	562	+24·4	+38·8
B114 („ 3)	463	− 4·9	429	−14·0	− 9·1
B 90 („ 4)	389	−26·9	470	−39·4	−12·5
Average	411	−14 9	441	−16·6	− 1·7

In this case also, though a substantial improvement has occurred in B 95, on the average the manured plots are left even further behind the control plots.

Table III

Yields of plots manured with 250 lb. of Superphosphate and 100 lb. of Muriate of Potash per acre per annum.

Plot	Average annual yield of dry cacao in unmanured period lb.	Percentage increase or decrease over control plot in the same group	Average annual yield of dry cacao in unmanured period lb.	Percentage increase or decrease over control plot in same group	Difference of percentage increase or decrease over control plot in manured period compared with unmanured period
C109 (Group 1)	425	− ·7	472	−3·1	−2·4
C8 (,, 2)	422	−10·9	403	−1·9	+9·0
C116 (,, 3)	474	− 2·6	485	−2·8	− ·2
C 92 (,, 4)	472	−11·3	710	−8·6	+2·7
Average	448	− 6·4	517	−4 1	+2·3

Once again we find that in two plots the yields have fallen still farther behind those of the controls, while in the other two plots an improvement has taken place. On the average the relative yields of the plots have improved by 2·3 per cent.

The experiment affords no valid evidence that yields have been increased by the application of either superphosphate, muriate of potash, or a mixture of the two.

It is true that this percentage-increase method is not considered a reliable one, but it is reasonable to suppose that, if the application of the manures had exerted any influence, a greater change in the relationship of the yields of the manured plots and those of the control plots would have appeared. In this connection it is of interest to note Lock's (1) summing up of the results of cacao manuring experiments carried out on the station between 1902 and 1911. He says: "We find, therefore, that the differences of crop which can be attributed to the action of definite chemical constituents are extremely slight, and it seems clear that the continued application of most artificial manures to a cacao soil like that of Peradeniya is a waste of money, under the conditions of this experiment."

The present writer made some remarks on this point in the Progress Report for the Station for the months of May and June, 1930. The following is the extract referred to:

"The yields of dry cacao per acre for the last seven years have been as follows:

Year		Cwt. per acre of dry cacao	Rainfall
1923-24	...	2·24	106·42
1924-25	...	3·10	103·82
1925-26	...	5·45	87·31
1926-27	...	5·03	98·11
1927-28	...	4·41	80·33
1928-29	...	2·49	88·95
1929-30	...	4·58	98·71

"From 1921 to January 1928, no manures were applied to the cacao. From January 1928, twelve out of the forty-one acres of cacao have received phosphatic and potash manures in accordance with the manurial experiment now in progress. The above yields tend to show that cacao yields fluctuate far more with the season than as the result of any manurial treatment."

To sum up it appears more than likely that there is no deficiency of phosphoric acid or potash in these soils and that in consequence the application of the manures has exerted no obvious effect.

One notable point is that all the three manured plots in group 2 show an improvement in yield relative to the control plot while no plot shows an improvement in group 1, and only one plot each in groups 3 and 4. This is difficult to explain. The plots which comprise group 2 are some of the best on the station and there is no obvious reason why they should have benefited more by the application of the manures than the plots in the other groups.

It is now necessary to examine the question of disease incidence. The average percentages of good cacao of total crops in the two periods are found in table IV for all three treatments.

Table IV

Plot	Average percentage good cacao of total crop in manured period	Same figure for control plot in same group	Increase or decrease in percentage good cacao over control plot	Average percentage good cacao of total crop in manured period	Same figure for control plot in same group	Increase or decrease in percentage good cacao over control plot	Difference of percentage relative to with control plot for manured period compared with unmanured period
A 5	76·2	76·4	− ·2	73·0	81·0	−8·0	−7·8
A 9	76·1	75 5	+ ·6	78·0	76·6	+1·4	+ ·8
A 115	79·2	78·9	+ ·3	79·0	83·2	−4·2	−4·5
A 91	77·5	79·5	− ·2	82·1	85 0	−2·9	−2·7
Average	77·2	77·6	− ·4	78·0	81·4	−3 6	−3·2
B 4	77 2	76·4	+ ·8	76·4	81·0	−4·6	−5·4
B 95	74·3	75 5	−1 2	83·1	76·6	+6 5	+7·7
B 114	78·4	78 9	− ·5	83 0	83·2	− ·2	+ ·3
B 90	71·5	79·5	−8·0	82·3	85·0	−2·7	+5 3
Average	75·3	77·6	−2·3	81·2	81·5	− ·3	+2·1
C 109	77·3	76·4	+ ·9	80·2	81·0	− ·8	−1·7
C 8	73·7	75·5	−1·8	79·3	76 6	+3·3	+5·1
C 116	81·4	78·9	+2·5	78·1	83·2	−5·1	−7·6
C 92	77·9	79·5	−1·4	83·6	85·0	−1 4	nil
Average	77·6	77·6	nil	80·3	81·4	−1·1	−1·1

If the application of manures has failed to increase the total yield it would appear unlikely that it would result in an increase in the proportion of good cacao, and from the figures in table IV this does not in fact seem to have occurred. The relative position of the superphosphate plots compared with the control plots as regards proportion of good cacao is worse by 3·2 per cent than before manuring. The muriate of potash plots show a small improvement of 2·1 per cent but the plots which have received both these manures show a deterioration of 1·1 per cent. There is little doubt that no influence has been exerted on the incidence of pod canker.

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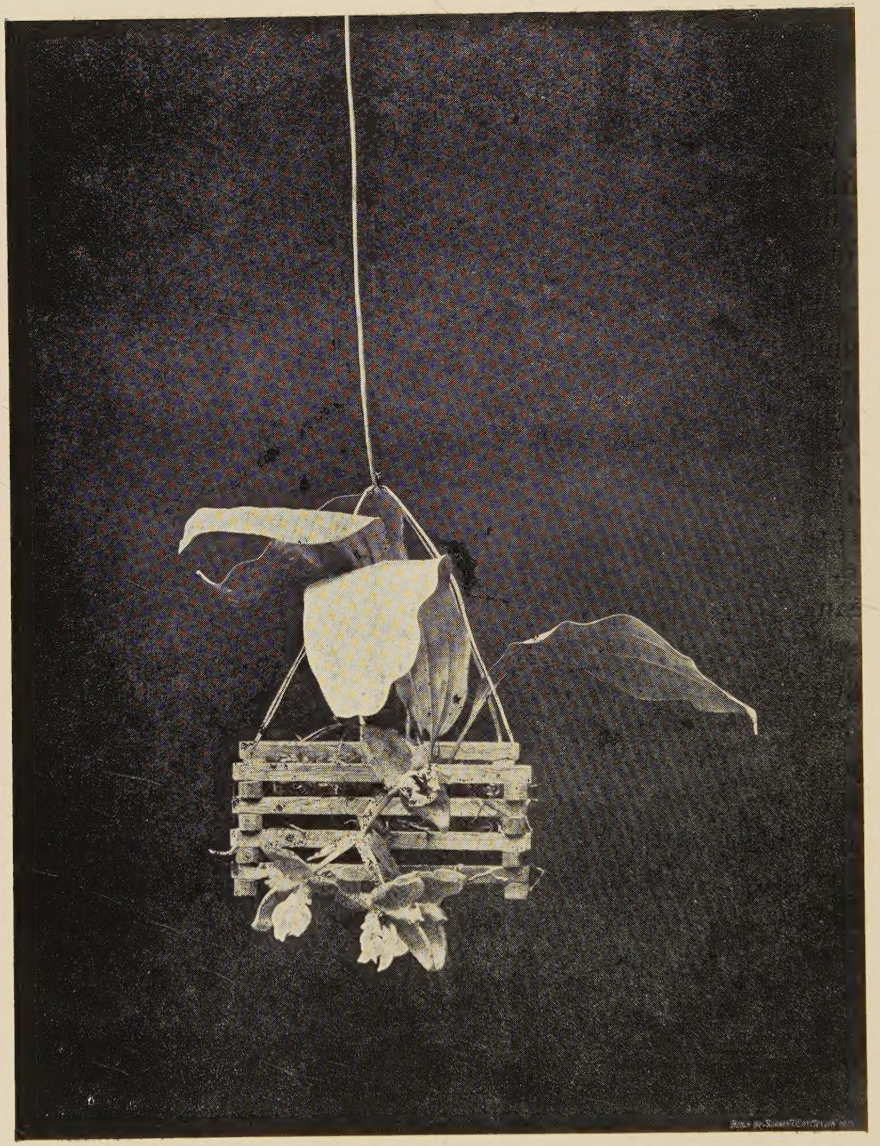

Stanhopea ecornuta Lem

STANHOPEA ECORNUTA

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Stanhopea ecornuta Lem. belongs to a most beautiful though not very extensive genus of epiphytic Orchids of the Vanda tribe. With the exception of *Stanhopea grandiflora*, which is a native of Trinidad, the majority of these are endemic in South and Central America.

The plants are pseudobulbous with broad shining deep-green membraneous plicate leaves. The flowers are peculiarly formed and of a very complex shape; the labellum and column forming together an exquisite cage-like structure, which narrows downwards and is of a waxy consistency. The flowers are large and beautifully spotted, and exhale a strong aromatic fragrance like that of Vanilla. The sepals, which all point upwards, are ear-like, about two inches long, concave, fleashy, and of a pleasing creamy-white colour.

The plant, owing to its pendulous flower racemes, is best grown in a shallow wooden basket, otherwise, the free development of the raceme is liable to be checked and result in deformed blooms. The rooting compost, as far as possible, should be of a fine character; and should consist of equal parts of broken charcoal, bones, coconut fibre, and sphagnum moss. When in active growth the plant should be given an ample supply of water and placed in a warm position though sheltered from direct sunlight. After the flowers are open the plant may be removed to a cooler position and watering reduced to once or twice a week. The flowers being very sensitive and delicate, care should be taken to avoid wetting them.

CONTRIBUTIONS FROM THE RUBBER RESEARCH SCHEME, CEYLON

DISEASES OF RUBBER IN CEYLON, 1930

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1. INTRODUCTION

THIS article is the second of a series of annual reviews on the general position of Rubber diseases and pests in Ceylon. The object of these articles, as stated on a previous occasion [1], is to keep planters in touch with the general disease position, and to acquaint them briefly of any important developments during the year under review.

2. ROOT AND COLLAR DISEASES

As regards fungus diseases there are no new developments to report for 1930. The low price of rubber has unfortunately necessitated the curtailment of control measures against the two most important fungi, *Fomes lignosus* and *Ustulina zonata*, and it is feared that considerable loss on account of these diseases may consequently be experienced in certain districts during the next few years. Every possible care to prevent the spread of root disease and *Ustulina* collar and stem rot should be taken, so that the necessity for the expenditure of large sums of money in the future may be avoided.

Termites.—A number of instances of attack on Rubber trees by termites ("white-ants") have been reported in Ceylon during the year. In Malaya and the Dutch East Indies *Coptotermes gestroi* has for some years been notorious as a root parasite of *Hevea*. This species, however, is not known in Ceylon, and until recently it was believed that none of the Ceylon termites were able to attack healthy Rubber trees. Unfortunately this view can no longer be entertained, and in the light of recent observations it is possible that the concern with which these pests have been regarded by the Tea planter for many years may, in future, be shared by the Rubber planter also.

An account of termite attack on *Hevea* in Ceylon is given by Jepson [2] in Rubber Research Scheme Quarterly Circular Vol. 7, Part 3. Broadly speaking there are two types of termite attack on *Hevea*:

(1) The termite can only gain entrance through dead or diseased wood such as is provided by *Ustulina* attack or a broken branch. Having thus gained entrance, however, it can attack and destroy healthy wood and may penetrate to the roots, thus causing the ultimate death of the tree. Certain species of *Calotermes* have been found attacking *Hevea* stems in this way. Such attacks can be guarded against by the removal of dead and diseased branches.

(2) The termite can gain entrance underground through a healthy root, and, working upwards, may hollow out the trunk and kill the tree. One species, *Coptotermes ceylonicus*, has been found attacking *Hevea* in this way, though it has usually been associated with a root disease fungus. This is the most dangerous form of attack and no effective preventive measures can be taken.

In view of the lack of precise knowledge regarding the habits of some of the genera and the circumstances under which they may attack *Hevea*, further records and specimens will be welcomed.

3. STEM DISEASES

On those estates which stopped tapping during May, the incidence of Bark Rot when the cuts were re-opened in June was not so severe as had been anticipated. Although this was largely due to the comparative failure of the S. W. monsoon there is no doubt that this disease can be almost entirely prevented if careful control measures are adopted.

Canker is not considered to be of much importance except where the actual tapping surfaces are effected. At the present time, when the expenditure on disease treatment must, in common with all other items, be reduced to a minimum, it would be advisable on most estates to transfer the money usually spent on canker scraping to the control of root disease and *Ustulina*.

4. LEAF DISEASES

Secondary leaf-fall due to *Phytophthora palmivora* (*P. Faberi*) was not serious in 1930. It is possible, however, that the effects of this disease may become more marked while the low price of rubber necessitates the curtailment of regular manuring and cultivation.

Oidium.—In the main low-country districts the intensity of *Oidium* attack has not increased to any serious extent since the disease was first reported in 1925. Although the disease is now widespread it would appear that the conditions in the low-country are not favourable to prolonged spells of severe infection. At mid-country elevations, on the other hand, the fungus continues to cause extensive and serious defoliation on many estates, and

there is evidence of considerable decreases in yield due to the disease. A fair measure of control has been secured by means of sulphur dusting, and it is confidently expected that further experiments will achieve better results.

It is of interest to note that Beeley [3], in Malaya, has found that the fungus sporulates more actively in a cold chamber (55°F) than at a normal tropical temperature. There can be no doubt that this fact provides the main explanation for the greater intensity of the disease at higher elevations in Ceylon.

A leaf scorch due to the application of calcium cyanamide in dry weather was much in evidence during the year. The margin of the leaf blade dies back and becomes whitish in colour, and the appearance is similar to that of a rim-blight of fungus origin. In severe cases the leaflets may fall. It is generally supposed that the burning is due to the formation of dicyanodiamide, a toxic compound which is liable to be formed in the absence of sufficient moisture. This manure is of great benefit when applied under suitable conditions, but it should not be applied in dry weather, particularly to soils deficient in humus.

5. DISEASES AND PESTS IN NURSERIES

The establishment of budwood nurseries for the multiplication of high-yielding clones has been undertaken by most companies, and nearly every estate in the main rubber-growing districts now possesses a certain number of stumps budded from proved foreign clones. The possession of such valuable planting material has focussed attention on the various ailments to which young shoots are prone.

The most serious fungus disease of young rubber buddings is a die-back of the green shoot caused by *Phytophthora palmivora*, the symptoms of which have been described by Murray [4]. Its incidence is markedly dependent on wet weather, and under favourable conditions a young shoot may be killed back in a few days. It is necessary, therefore, to keep a careful watch on nursery plants and to cut back any diseased shoots well below the margin of the discolouration. Successful control has been secured on many estates by periodically spraying with Bordeaux Mixture.

An attack on young bud shoots by *Rhizoctonia solani* was reported by Park [5] from an estate in the Kalutara district. This fungus is a common cause of disease on *Vigna* (*Dolichos Hosei*), but has not previously been reported on *Hevea*.

Various pests attack young shoots and check their growth. Mites cause distortion of young leaves chiefly in dry weather, and are most effectively controlled by dusting with sulphur powder. Slugs are often found to eat off the terminal shoot. By day it is

usually possible to find the slugs under stones, etc., and flat boards may be put down to trap them. They may be to some extent discouraged by periodically dusting with smokehouse ashes, and by putting a barrier ring of ashes on the ground round each plant.

It is a sound practice to spray all young shoots of valuable bud-grafted material with Bordeaux Mixture every week or ten days during wet weather, and to dust them periodically with sulphur powder during dry weather.

[For further particulars regarding diseases and pests in nurseries reference may be made to *Rubber Research Scheme Quarterly Circular* Vol. 7, Part 3, 1930, (6)].

COVER CROPS

The impression has been gained that the Kalutara snail (*Achatina fulica*) is not now causing so much damage to *Vigna* as formerly. The dying back of many areas of this cover is probably to be attributed to staling effects.

There has been no extensive fungus damage to cover crops.

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THE EFFECT OF BLANKETING ON THE PLASTICITY OF CREPE

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IN Bulletin 49, p. 7, attention was drawn to a statement by Mr. O'Brien that "the procedure adopted in blanketing crepe varies considerably. For example in certain factories water-cooled rolls are used so that the temperature of the rubber is kept low. On other estates uncooled rolls are used, but are allowed to cool down after half-an-hour's work. Again on other estates there is no interval for cooling and the rubber temperature may rise to 50-55°C. The number of rollings may vary from three to five."

A set of samples was therefore prepared to determine the effect of different practices during blanketing on the plasticity of crepe, and it was concluded from the results of tests that rolling for blanketing purposes might cause a considerable increase in plasticity particularly if the rolls were not water-cooled. Some of the results were irregular and required confirmation.

A further set of samples has now been prepared to study the effect on plasticity of conditions of rolling during blanketing. The samples consist of lace crepe (control), crepe passed three and six times respectively through water-cooled blanketing rolls, and crepe passed three and six times respectively through somewhat hotter air-cooled blanketing rolls.

The following are the results of plasticity tests:

Sample No.	Treatment during blanketing	Before storage	After storage for six months at 32°F		60°F	
		D_{30} mms / 100	D_{30} mms./ 100	Mastic-ation No.	D_{30} mms./ 100	Mastic-ation No.
1496	Lace crepe (control)	171	155	92	165	93
1494	3 rollings water-cooled rolls. Temperature of rubber 41°C	155	170	100	168	99
1497	6 rollings water-cooled rolls	160	153	97	162	97
1498	3 rollings air-cooled rolls	156	155	95	162	100
1499	6 rollings air-cooled rolls. Temperature of rubber 58°C	156	145	87	151	84

The samples were tested soon after arrival in London and the control lace crepe was found to be distinctly harder than the blanket crepe samples. On storing for six months at 60°F, however, the control sample became softer and did not differ greatly from the others.

The sample which was blanketed under extreme conditions by rolling six times on comparatively hot rolls became much softer than the others on storage and required less mastication. The other samples did not show marked differences.

It is concluded that blanketing has little effect on plasticity when the temperature of the rolls is kept low but that it may have a marked effect if the rolls become hot. On the whole this agrees with the results of previous tests (Bulletin 49, p. 7). To obtain rubber of uniform plasticity it is desirable that the blanketing rolls should be water cooled.

NEW DATA ON THE LATEX TUBE BORE IN RUBBER*

AT the end of 1928 Mr. H. Ashplant, the rubber specialist, United Planters' Association of Southern India, gave a lecture on latex tube bore before the Rubber Growers' Association in London; it was published in the Bulletin of the "Rubber Growers' Association," Vol. X., No. 12, December 1928, p. 796. The original ideas and the new data, put by him before his audience, stirred up somewhat the rubber world. Most research workers in the rubber-growing industry were sceptic about the new method, a selection based on the latex tube bore, as a means for improving the planting material with rubber. In more than one station investigations about the new subject were started, but heard little about the results. Recently one of the members of the staff of the AVROS Experiment Station in Sumatra, Dr. Frey-Wyssling, has published the results of a careful study of the tube bore character (in the *Arch. v.d. Rubbercultuur in Ned. Indie,* Vol. XIV., No. 3, March 1930, p. 133, "Investigation into the relation between the diameter of the latex tubes and rubber production of Hevea brasiliensis"). Dr. Frey-Wyssling's data do not confirm Mr. Ashplant's theory.

Before going into the subject we must mention here a serious handicap for Mr. Ashplant. Circumstances did not allow him to give us further details about his method and more data on the application of it. There was certainly an excellent starting idea in his work. If we could find a reliable character to make out, if a young seedling in the nursery belongs to the group of future high-yielders always found among seedlings, this would mean an immense progress for the rubber-growing industry. Mr. Ashplant had the original idea to try to find it in the latex tube bore and he found a clever solution for many difficulties in relation to it by choosing the leafstalk for studying this character. Whatever the future development of Mr. Ashplant's method may be, he has certainly the merit of having given a new stimulus to investigations into the anatomy of Hevea bark.

The Difficulties of the Technique.—Up till now Mr. Ashplant has not described the technique of his method and Dr. Frey-Wyssling had, therefore, to spend much time in working out a flawless micro-technique for measuring the diameter of the latex tubes. He has given a very complete description of his methods; the results showed how difficult and delicate a work the measuring of the latex tubes is. To make the microscopical preparations two methods were tried; (1) the maceration method, and (2) the Eau de Javelle method. For calculating each average figure 100 measurings were made. The following figures were found:

(1) The figures are taken from Dr. Frey-Wyssling's article but some details are left to make the form as clear and plain as possible.

* By Dr. P. J. S. Cramer, Wassenaar, Holland, in *The Malayan Tin and Rubber Journal,* Vol. XX, No. 22, 1931.

Table I

Average Diameter of Latex Tubes

Individual number	In the bark	In microne 1
	Bark samples prepared by mac. method	Bark samples prepared by E.D.J. method
(a) Artificial crosses seedlings.		
Tree No. 1	26·7	23·8
,, No. 4	28·2	27·0
,, No. 6	27·9	24·7
(b) Marcots of cl. 180.		
Tree No. 8	25·6	22·9
,, No. 10	57·6	23·3
,, No. 12	26·6	22·7

The figures show that samples of the same tree, prepared by the maceration method, gives us always a higher figure, sometimes a considerably higher figure (Tree No. 10, 4·3 microns) than the Eau de Jevelle method. The three last trees are all marcots of the same clone and should, according to Mr. Ashplant's theory, all have the same average for the tube bore; even prepared with the same method, the samples show a difference for the average of 2 microns. This makes this method unreliable.

Dr. Frey-Wyssling used for calculating his averages 100 measurements of the same tree; by a mathematical reasoning he shows that this figure is sufficient, but that, if only 10 measurements were made per tree, quite valueless averages would be obtained.

Mr. Ashplant assures that this method can be applied with 80 per cent. efficiency. Without a detailed description it is not clear how he avoids the difficulties mentioned by Dr. Frey-Wyssling. With the experience of the last, one would say that, when the method has to be applied in estate practice and the measurements made by native staff it will require a good deal of supervision to get, with such a delicate and complicated method, reliable results.

I would not dwell further upon this point. Let us take it for granted, that the men, who do the work, do it as well as the botanists in the laboratory and examine them, if the method gives the results Mr. Ashplant expects from it.

The Figures with Buddings.—The difficulty is, that we need years to compare the character—the average width of the latex bore in young plant with the yield of the adult tree. Dr. Frey-Wyssling tried to overcome this difficulty by using six months old buddings, instead of six months old seedlings. We have the advantage with buddings, that we know beforehand, what they will give as adult trees.

Dr. Frey-Wyssling used for this test twelve popular AVROS-Clones all planted on a large scale now in Sumatra and for the largest part also used in experimental plots, for which the yield has been studied for a number of years. He gives his results in a table, which we have rearranged to make it speak more clearly. For each clone the average width of the latex tube was measured and calculated.

We have now classified the clones according to the width of their tubes.

Table II

Yield and Tube Width with Clones.

Clone Number	Aver. diameter of latex tubes in leaf-stalk	Grams of dry rubber per tapping in tapping year		
		In 1st Year	In 2nd Year	In 3rd Year
50	16·4 microns	6·1	14·7	30·3 grams
49	16·5 ,,	6·2	14·5	21·3 ,,
35	17·3 ,,	6·8	16·3	18·3 ,,
33	17·4 ,,	5·5	11·2	23·8 ,,
80	17·5 ,,	6·3	12·1	15·2 ,,
163	17·5 ,,	7·8	12·7	20·8 ,,
152	17·6 ,,	9·7	17·1	23·6 ,,
36	17·8 ,,	4·2	10·0	20·3 ,,
214	18·3 ,,	15·2	—	—
71	18·6 ,,	7·8	12·8	21·8 ,,
183	18·8 ,,	14·8	24·0	—
256	19·3 ,,	—	—	41·7 ,, (4th tap year.)

If we compare these figures with those for common seedlings, we find that none of these clones shows an outstanding figure for its tube diameter, compared to common seedlings. If we read through the figures for the yields in the second and third year we do not find back the same consequence as in the classification of the tube diameter. Clone 50, one of the best yielders in third year, heads the list, that means shows the lowest tube diameter. Clone 71, one of the lower-yielding clones, comes near to the top with its bore.

But more than these relatively small differences says the following case. The AVROS Station disposes of one clone, used for comparisons, of a very poor yield—in its first year it gave only 0·6 gr., in its second year only 1·3 gr., and the latex tube diameter of this very poor clone averages 18·1 microns, which places it among the ones with a diameter above the average.

Results of Selection on Tube Width.—Another way to put the selection method recommended by Mr. Ashplant through the proof is by applying it. We can use for such a practical proof the 239 trees Mr. Ashplant studied himself and further two sets of trees described by Dr. Frey-Wyssling. In these three cases the yield of the adult tree is given together with the average tube width in the leafstalk. As, according to Mr. Ashplant, this character remains constant throughout the life of the tree, we can figure ourselves that we selected the trees, when still young, on the tube diameter, planting out only those with the highest average.

(a) *Mr. Ashplant's Trees.*—Table III is copied from Mr. Ashplant's lecture; it is only somewhat simplified and a few printer's errors have been corrected. In the horizontal direction the trees are classified according to yield, in the vertical direction according to tube width. The average yield of all the trees is 32·5 cM^3. Mr. Ashplant has calculated, that early selection by means of bore measurements can give a stand of rubber $2\frac{1}{2}$ times the yielding capacity of present stands on the same area. $2\frac{1}{2}$ times 32·5 cM^3 is 81·2 cM^3. If we take the two trees with broadest tubes—those at the bottom of the table with a tube diameter of 20 microns—their yield is $78 + 99$ $cM^3 = 177$ cM^3, or the average per tree is $177 \div 2 = 88{\cdot}5$ cM^3. If we add the class with second broadest bore, 19 microns, we find one tree with a yield of 60 cM^3; for the three trees together the yield would average $(177 + 60) \div 3$ or 79 cM^3, what is already

less than 2½ times the average for all trees. It is easy to read from the tables that including further groups (with third widest tube bore 18·5 microns and so on) will reduce considerably the average yield of the selected trees. Mr. Ashplant says, after having cited the possibility to raise the yielding capacity to 2½ times the one of the present stands, that assuming only ordinary skill and experience and allowing for a few misses one can still safely reckon doubling the present productivity. Yes—if one plants only out of 239 trees in the nursery the two trees with widest bore, less than 1 per cent of the total number. It means, that for doubling the yield we have to raise and to submit to microscopical examination one hundred times the number of plants needed.

If we are less ambitious and use, say 33 per cent of our plants the 79 with widest bore, what will be the improvement? The dotted line in Table IV indicates which plants would be selected then. We can add up their yields and divide the sum by the number; the average per selected tree becomes then 49·5 cM^3, or 151 per cent the average for all 239 trees. Under ideal conditions the improvement by planting only 33 per cent of the trees with widest bore would be 151 per cent; in practice it would be, like in the former case, less, certainly well below 50 per cent.

(b) *Sumatra Trees, Common Seedlings.*—Let us now apply the selection of the plants Dr. Frey-Wyssling studied. The tables for his trees are reproduced here in a simplified form and the trees are classified according to tube width. The first set of his comprised 14 seedlings from a native place (Table IV). The average yield for all trees is 6·9 grams. We plant only the 33 per cent or 5 trees, with widest tubes; their average yield can be calculated at 9·2 grams, 133 per cent of the average for all 14. So the selection on tube bore would have improved the yield, but—even if no allowance is made for slips in the practical application—only with 33 per cent, not much more than half the gain with Mr. Ashplant's trees. And to reach this improvement we would have to reject 2/3 of our trees, after examining them all.

Table IV

Common seedling trees in Sumatra classified according to diameter of latex tubes:

Tree Number	Diameter of latex tube in leafstalk	Average yield per tapping	
		In 6th year	In 7th year
No. 1	14·4 microns	—	3·3 gr.
,, 5	14·5 ,,	5·0 gr.	5·2 ,,
,, 11	14·9 ,,	5·1 ,,	7·4 ,,
,, 4	15·7 ,,	5·5 ,,	7·0 ,,
,, 2	15·8 ,,	—	2·1 ,,
,, 10	16·2 ,,	7·2 ,,	9·2 ,,
,, 13	16·7 ,,	4·4 ,,	3·6 ,,
,, 9	17·0 ,,	—	3·3 ,,
,, 7	17·2 ,,	6·5 ,,	8·0 ,,
,, 14	17·4 ,,	2·3 ,,	3·3 ,,
,, 8	17·7 ,,	7·0 ,,	6·8 ,,
,, 3	18·2 ,,	6·8 ,,	8·8 ,,
,, 12	18·2 ,,	12·5 ,,	19·2 ,,
,, 6	19·1 ,,	4·7 ,,	7·7 ,,
Average for all trees:	16·6 microns		6·9 gr.
Average for ⅓ of trees with highest yield	17·8 microns		10·6 gr.
Average for ⅓ of trees with widest latex tubes	18·2 microns		9·2 gr.

Table V

Average for all seedling trees, raised from seeds 157 × 185, classified according to diameter of latex tubes:

Tree Number	Diameter of latex tube in leaf stalk	Average yield per tapping	
		In 6th year	In 7th year
No. 3	16·1 microns	16·6 gr.	19·2 gr.
,, 5	16·3 ,,	23·1 ,,	28·8 ,,
,, 1	16·4 ,,	15·6 ,,	23·7 ,,
,, 9	17·0 ,,	14·7 ,,	20·0 ,,
,, 6	17·3 ,,	26·5 ,,	32·5 ,,
,, 7	17·4 ,,	22·9 ,,	34 9 ,,
,, 11	17·4 ,,	36·6 ,,	49·3 ,,
,, 8	17·4 ,,	21·9 ,,	32·0 ,,
,, 10	17·7 ,,	24·1 ,,	32·7 ,,
,, 14	17·8 ,,	5·4 ,,	6·0 ,,
,, 4	18·8 ,,	24·4 ,,	34·6 ,,
,, 2	18·3 ,,	12·5 ,,	17·0 ,,
Average for all trees:	17·3 microns		27·6 gr.
Average for ⅓ of trees with widest latex tubes:	18·0 microns		22·6 gr.
Average for ⅓ of trees with highest yield:	17·7 microns		37·9 gr.

(c) *Sumatra Trees, High-Class Seedlings.*—Dr. Frey-Wyssling describes also a set of 12 trees, grown from seeds obtained by the artificial crossing of two high-yielding trees (Table V). They are far more productive than common seedlings; the average yield is 27·6 grams, or four times the average of the last.

If out of these 12 trees we take the ⅓ with widest tubes—4 trees— and calculate their average yield, we find that it is only 22·6 grams, 5 grams less than the average for the unselected trees. So applying the selection on tube bore would have reduced the crop of our trees, instead of improving it.

The result of selecting the ⅓ of the trees with widest bore is, that in our case—with Mr. Ashplant's trees—we obtained a maximum improvement of 51 per cent; in another case of 33 per cent and in the third case no improvement, but a lowering of the average crop. These figures show, that the selection on tube width does not stand the proof and that it is certainly not reliable enough to be recommended to the practical industry.

Comparison of the Three Sets of Plants and Buddings.—Besides trying the effect of tube diameter selection on the three sets of trees, we use them also for comparing averages. If there is a close correlation between tube width and yield, we may expect that the groups of trees with same average yield show the same average for the diameter of the latex tubes, and vice versa that if the average of the tube width is the same, the yield will not differ much either. To render such comparisons easy I have made table VII. For each set of trees we have calculated the average yield and the average tube diameter, at first for all trees, and then for the ⅓ of the trees with widest tubes and the ⅓ with highest yield,

Table VI

Comparison of the averages for latex tube diameter and for yields with the groups of trees studied and the effects of the selection in per cent increase :

Ashplant's trees.			Average yield per tapping in grams effect
Unselected	...	...	10·8
Sel. acc. t. tube	...	...	16·4 + 31 per cent.
Sel. acc. t. yield Sumatra trees, common unselected	...	...	6·9
Sel. acc. t. tube	...	...	9·2 + 33 per cent.
Sumatra trees, 157 × 165 unselected	...	...	27·6
Sel. acc. t. tube	...	...	22·6—18 per cent.

The yield for Mr. Ashplant's trees has been calculated from his figures in cM^3 by dividing them by 3 to obtain the yield in dry rubber.

It is curious to state, that there is a marked difference between the common seedlings Mr. Ashplant described and the ones in Sumatra in relation to tube bore, a difference as much as 2·7 microns, nearly 20 per cent of the average. We would not expect this and I cannot find an explanation for it. But, what is still more curious, the average yield is for both sets of trees practically the same. With the large difference in tube bore, no difference in yield corresponds.

If in this case the conditions of environment differ considerably, this factor is eliminated if we compare the high class Sumatra seedlings with the common ones; both are grown under entirely similar conditions. We find, that for the high class plants the tube width is 17·3 microns, only 0·7 microns more than for the common plants, while the yield is 27·6 grams versus 6·9 grams, exactly 4 times the one of common plants.

There again our comparison does not confirm Mr. Ashplant's theory. We find that a large difference in diameter of latex tubes does not correspond with a higher yield, and in the other case, that a very considerable difference in yield does not correspond with a large difference in the average latex tube width.

On the other side, we can compare the average yields of the three classes of seedlings with those of the popular AVROS-Clones. Table VII gives the figures, obtained by Dr. Heusser, in a set of experimental plots now about 10 years under observation.

Table VII

Yield of AVROS-Clones per tapping.

		Seventh year	Eighth year	Ninth year	
AVROS	33	27·6	29·9	31·8	grams
	36	24·8	33·2	41·4	,,
	49	32·5	35·8	34·5	,,
	50	34·0	29·5	31·1	,,
	80	25·7	27·8	35·7	,,

If we compare these yields with the averages for common seedlings and for the ones selected on tube width, we see, that if the latter figures show some improvement, they still remain far behind the averages for the popular clones. Only the high class seedlings come near to these clones in yield, but on this set of trees the tube width selection was a complete failure and further seeds of this high quality are not available.

Apart from the yield there are other characters, like vigour and resistance against diseases, which count, if we want to judge the value of our planting material.

According to Mr. Ashplant (R.G.A., p. 802) he has discovered a number of snags with budding: weak growth, weak renewal, possibly greater susceptibility to disease, undoubtedly greater susceptibility to Brown Bast. Those, who are familiar with our present clones will not share this opinion. On the contrary, we have clones which in vigour and resistance against diseases surpass our common seedlings. There is a special point in favour of budgrafting, compared to seedling selection and that is the great uniformity in special characters.

With seedlings grown from the best selected, clonal seeds, even if they are obtained by self-fecundation, such a uniformity will never be reached with our present material. There is a good chance, that some of our clones now popular among planters in Java and Sumatra will show special advantages, for instance a greater resistance against secondary leaf-fall or against drought. If such a clone is found we are certain, that it will repeat this character in all its buddings, while with seedlings we are never sure we will always find variations in the degree of resistance.

In many circles there is still a prejudice against budgrafting, a lack of faith in the results obtainable by this process.

Instead of arguing with yield figures, I will cite statistical data for Sumatra, where in 1929 practically all extensions were planted with budgrafts, pure and mixed with seedlings.

The Extension with Buddings in Sumatra.—Since 1920 buddings are planted on a fairly large scale in Sumatra. In the first year after 1920 generally mixtures of buddings and seedlings were planted with the idea that if the buddings turned out to be less satisfactory, the seedlings only could be kept. Also a fair percentage of the extensions were planted with seedlings, grown from selected seeds, in former years mostly seeds taken from high-yielding trees in common plantations.

At present seeds from clonal plantations become available and possibly selected seeds are now mostly clonal seeds. In the first year only part of the extensions were planted with improved material.

In table VIII we have put together the figures, calculated in acres, for the total extensions of each year and for the average under buddings, under buddings mixed with seedlings and under selected seedlings. From these figures the percentage figures are calculated. They give the percentage of the group of the total extension, the percentage of the total extension with improved material, total of per cent figures column 1, 2, and 3, and the percentage with buddings mixed with seedlings, column 1 + 2.

From these last figures we may conclude, that planters in Sumatra have abandoned entirely the planting of common seedlings; column 4 shows that in the last two years all extensions were planted with improved material. The table shows further, that there is a tendency to turn more to buddings. Column 5 shows a gradual increase in the percentage of the fields planted entirely and partially with buddings. We see further, that there is a growing confidence in buddings. The percentage of the extension with pure buddings, see column 1 becomes larger every year.

Table VIII

Figures on extensions with improved material in Sumatra (in acres).

Year	Total extension	1 Pure buddings	2 Budding a seedlings	3 Selected seedlings	4 Improved material	5 Budding a mixture.
1924	22·252	2·580	5·975	4·215		
		11·6%	26·9%	18·9%	57·4%	38·5%
1925	20·630	1·350	11·338	1·732		
		6.5%	55·0%	8·4%	69·9%	61·5%
1926	34·182	8·648	16·432	7·070		
		25·3%	48·1%	20·7%	94·1%	73·4%
1927	40·507	9·758	21·345	9·040		
		24·1%	52·8%	22·3%	99·2%	76·9%
1928	44·257	13·782	23·937	6·537		
		31·1%	54·1%	14·8%	100%	85·2%
1929	32·960	19·340	12·310	1·310		
		58·7%	37·4%	4%	100%	96·0%

Conclusions.—From the figures and comparisons resumed above may be concluded, that the selection average tube diameter in the leafstalk has no value for improving the yields per acre. If we study it from various angles we find that yield and tube width are not so well correlated as Mr. Ashplant thought them to be. In this respect we may cite Dr. Frey-Wyssling's conclusion, that trees with narrow tubes are poor yielders, but trees with wide tubes are by no means always good yielders of rubber. This is a serious drawback against practical application of the method. It is more important for the efficiency of our selection, that we exclude all poor yielders, than that we include all high yielders and it is just on this point that the method fails.

If we apply the method on the three sets of trees, for which yield and tube diameter has been studied, we find that in the two cases, where some improvement was reached, with common seedlings the improved yield remained still far behind the yield which may be obtained with the popular clones.

From this we may conclude, that at present the best way to raise our crop per acre is to plant the best clones now available. That is, what planters in Sumatra have started to do some years ago; from the statistics may be concluded, that they have more and more confidence in buddings. The safest policy for planters in other rubber-producing centres of the world is to follow their example, till perhaps in a further state of the technique of rubber-growing new methods are found, easy to apply, efficient and reliable. I do not think, that the selection on tube diameter responds to those three demands.

NATIONAL BOTANIC GARDENS*

THE principal objects of national botanic gardens may briefly be summarised under the three headings: educational, research, and economic. Perhaps a fourth function of a botanic garden should be mentioned, namely, that of recreation. Any orderly garden performing the functions of education and research, and carrying out certain useful economic services, must necessarily provide a place for pleasure and recreation, for nothing is more beautiful, or provides a more restful place, than a well-kept garden. A garden may, indeed, be a place of recreation, without performing in any noteworthy way any of the three main functions mentioned above, and such, I am afraid, is the case of many gardens which go under the name of botanic gardens.

As regards the educational objects a botanic garden should provide information for all those who wish to learn about plants, not merely their names, which the enquirer should be able to get by an inspection of the gardens, but also the uses of plants, which the officers of the gardens should be able to supply either of their own knowledge or from specimens, or from publications issued by the gardens.

The method of fulfilling the educational function of a botanic garden is therefore by maintaining a classified and named collection of living plants, and also a museum of plant products. Material should be available for the use of teachers in educational institutions, while the public are more directly reached by lectures, and popular publications.

The research activities of a botanic garden should concern themselves with the exploration of the native vegetation of the country; with investigations into its economic possibilities—for instance, the properties of vegetable oils, tannins, timbers, and drugs; with numerous ecological and evolutionary problems such as the effects of changes of climate on plants; with the production of new forms by hybridization or other means; with breeding and crossing to show the taxonomic status of wild plants; and generally with the behaviour of plants under changes of soil.

Most of such work should be done in the garden's nursery section, though many of the plants on view to the public may also be under observation for some specific purpose. In connection with research work a laboratory, herbarium, and library are required. A large botanic garden should produce sufficient scientific material to justify the issue of a regular publication.

The economic value of botanic gardens will be perhaps of most interest, especially to the community among which the funds out of which the gardens are maintained are raised.

Included among the functions of a botanic garden of economic importance are the acclimatisation of useful plants, the distribution and exchange of seeds, the quarantining of imported plants, and the publication of useful information. The gardens should be used for the vocational training of horticulturists, while surplus plants should be available to public institutions.

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* From a lecture by W. R. B. Oliver, M.Sc., Director, Dominion Museum, Wellington, in the *Journal of the New Zealand Institute of Agriculture,* Vol. 2, No. 4, March 1931.

Taking the essential idea of a botanic garden as the growing of different kinds of plants in order to study them from either a scientific or economic view-point, then its development must be traced through the early temple gardens, and gardens where medicinal and other useful plants were grown, including especially the garden of Aristotle who was a student of botany. In the 16th century the herbalists began to grow plants for the purpose of study, and from these gardens sprang directly the modern botanic gardens. The first of these appear to be those founded in Italy about 1540, and the first herbarium that founded by Geraldo Cibo at the same time and now preserved in Rome. The idea of establishing public botanic gardens spread rapidly, and before the end of the 16th century there were several such in Italy, Holland, Germany, and France. One of the most important of the early gardens was that founded at Pisa in 1543. The second director of this garden was the famous botanist Andrea Caesalpini, and its influence accordingly spread far. Other early Italian botanic gardens were those of Padua, Florence, and Bologna. The earliest public botanic gardens in other European countries were Leiden (Holland) 1577, Leipzig (Germany) 1579, Montpellin (France) 1592, Copenhagen (Denmark) 1600, Upsala (Sweden) 1627, Oxford (England) 1632, and Marid (Spain) 1763. The earliest Asiatic botanic garden is said to be that at Tokyo established in 1638. The garden at Sibpur, Calcutta, dates from 1787, Peradeniya (Ceylon) 1813, and Buitenzorg (Java) 1817.

In Australia there are some long established botanic gardens that of Sydney dating from 1816, and that of Melbourne from 1842.

The earliest American garden is the Missouri Botanic Garden founded in 1859. The Arnold Arboretum was established in 1872, and the New York Botanical Garden in 1894.

Perhaps the chief educational function of a national botanic garden is the maintenance of a collection of living plants. In the larger gardens this is carried out to the point of growing as many as 25,000 species, as at Kew, named and, as far as the exigencies of space and landscape effect will allow, classified according to their relationships. The Buitenzorg Gardens contain about 20,000 species, and lesser numbers are reported from the other great gardens of the world.

Complementary to a collection of living plants are the collections of dried plant-products forming botanical museums. These may exhibit not only specimens and pictures designed to illustrate the most striking plants of the world but also commercial products derived from plants, such as timber, fibres, dyes, drugs, tanning material, oils, gums, and rubber. Museums are established in all the larger gardens. At Kew there are four museums, in addition to the North Gallery containing 800 paintings of plants and vegetation by Miss Marianne North. At Buitenzorg both botanical and zoological museums are maintained in the gardens.

The gardens and museums are the chief branches of a botanical institution open to the public, and as an indication as to how they may be appreciated, the tally kept at the Kew Gardens may be quoted. This shows that the average annual attendance is about 3,000,000.

Of equal importance with the educational functions of a botanical garden is its research work. For this a staff of trained botanists and chemists is kept in all the larger institutions. Their work consists not only in investigaions on the flora of the country in which the garden is situated, but in the case of the larger institutions the field is practically world-wide. Thus the officers at Kew carried out the preparation of a number of floras of different parts of the British Empire, and for many years sent collectors out to various parts of the world, while the New York garden has a station for plant study established in the Blue Mountains in Jamaica.

In Edinburgh and other gardens are laboratories open to anyone desirous of undertaking botanical research, while all gardens supply on request information on specimens for the use of specialists.

The herbaria established in the world's largest gardens have attained immense proportions, those at Kew and New York, for instance, each containing more than 2,000,000 specimens.

The results of the research carried out by the scientific staff of botanical gardens are published in various monographs and other works and serial publications. Among the larger works may be mentioned the Index Kewensis, which is an alphabetical list of every plant name (other than garden names) published, and is still being carried on by decennial supplements; and the various colonial floras issued by the Kew Gardens. The New York Botanical Garden is issuing an extensive work on the North American flora. The "Revision of the Genus Eucalyptus" published by the Sydney Botanic Gardens may also be mentioned here. The periodicals issued by botanical gardens include such important publications as the following: Kew Bulletin, Curtis' Botanical Magazine, Memoirs of the New York Botanical Garden, Mycologia, Annals of the Royal Botanic Gardens at Peradeniya, and the botanical journals issued by the Buitenzorg Gardens.

The economic work of botanical gardens naturally appeals most to the average person who desires to see some immediately useful return for the money expended in the upkeep of the garden. Such a view is, however, quite a narrow one, as it entirely overlooks the æsthetic, intellectual, and social pleasures derived from the beauty, knowledge, and personal contacts derived from well-kept botanical gardens and from botanical societies. However, as in point of fact the economic interest appeals to a more numerous class than the others, the economic functions of botanical gardens as here defined will be described a little more in detail than the educational and research functions though these are of course, of great economic importance, albeit this may not always be immediately seen. In relation to the economic importance of botanical gardens the following statement made by Mr. Joseph Chamberlain in the House of Commons in 1898 will bear frequent repetition.

> "I do not think it too much to say that at the present time there are several of our important colonies which owe whatever prosperity they possess to the knowledge and experience of, and assistance given by, the authorities at Kew Gardens."

The leading part in the distribution of useful plants to various parts of the British Empire undoubtedly has fallen to Kew Gardens. It was after the appointment of Sir Joseph Hooker, as Director in 1865, that the introduction of new and useful plants to the Dependencies of the Empire and the fostering of new industries in connection therewith was especially made one of the chief duties of the gardens. A great many kinds of useful plants have since been distributed to new centres through the instrumentality of Kew. They include various plants producing fruits—pineapples, bananas, breadfruit; beverages—tea, coffee, cocoa; drugs—quinine, coca; fibres—sisal hemp, New Zealand flax, ramie; besides rubbers, dyes, and timbers.

Both romance and tragedy enter into the story of the first attempt to introduce the breadfruit from the South Sea Islands to the West Indies. In this venture Kew was intimately concerned. A gardener named Nelson was attached to the expedition which set out in the *Bounty* in 1787 under Captain Bligh. One of the objects of this expedition was to obtain breadfruit plants in the Society Islands. After sailing from Tahiti, where the vessel remained for about six months, a mutiny broke out on board

the *Bounty* and Bligh and eighteen others were set adrift in an open boat. After a journey of 3,600 miles the Dutch settlement of Timor was reached, but here Nelson died. The breadfruit was successfully introduced to Jamaica in 1791 with the aid of a Kew gardener, Christopher Smith.

The quinine plant, Cinchona, was introduced from South America through Kew to India in 1860, the seeds being first obtained by Sir Clements Markham. At that time it was costing the Government of Bengal £40,000 a year for quinine. Now a dose of 5 grains can be bought for less than a farthing at any post office, while in England the price is one-sixteenth of what it was then. In Ceylon the Peradeniya Gardens played an important part in the establishment of the Cinchona industry in that country, millions of plants being raised and distributed to growers. It was this industry which helped the planting interests to tide over the period between the collapse of coffee and the establishment of the tea industry.

Rubber is an article of daily use, indispensable in the electrical, motor, and other industries, and up to quite a recent date the world was dependent for the best of all rubbers, the para rubber on natural supplies obtained from the tree *Hevea brasiliensis* in the forests of South America. The seeds are very short-lived, but in 1875 some obtained by Sir Henry Wickham from the forest of the Tapajos Plateau, Amazon Valley, were forwarded to Kew. From these 1,000 plants were raised and sent to Ceylon and the Malay Peninsula, thus establishing the species in those regions.

The above examples briefly summarising the transfer of the breadfruit, cinchona, and para rubber plants from one hemisphere to another should suffice to show the important part that botanical gardens have taken in the establishing of industries in different parts of the world.

It remains now to mention two other functions being carried out by botanical gardens: One is the distribution and exchange of both useful and ornamental plants which is carried out extensively by all national botanical gardens, and the other is the training of horticulturists. Two famous training grounds are Kew, where courses of study are laid out which fit horticulturists, especially for appointments to the botanic gardens of the Empire; and Edinburgh, where the course is free, but anyone not showing satisfactory progress is removed.

Finally, it is worth mentioning that the Botanic Gardens of Adelaide maintains a type-fruit orchard, including apples, pears, plums, and peaches, and from which buds and scions are available to growers.

SYSTEMS OF AGRICULTURE AND THE POSITION OF TROPICAL AGRICULTURE* PART I

IT has always been taken for granted that agriculture in the tropics has its own peculiar character. This need not be wondered at: the tropical differs very much from that in a northern climate, tropical soils show features not common to our European soils; lack of winter, an abundance of crop pests, and, in a large part of the tropics, an extensive rainfall and high degree of humidity, all these factors make conditions of plant production different from those we are used to.

And so as a matter of convenience tropical agriculture was distinguished from agriculture in countries at higher latitudes.

But, when exploring the field of tropical agriculture and its science, one looks for its boundaries, trouble begins. For if "tropical agriculture" does not mean anything more than agriculture in tropical countries, the difference from agriculture in other countries is only a geographical one.

This question brings us directly in contact with the question of the classification of types of agriculture.

Nobody will deny that the ways in which agriculture is practised the world over show very large differences: agriculture in humid west European countries differs greatly from that in the large arid plains of North America and perhaps still more from Chinese and Japanese agriculture. As there are large differences between agriculture in different parts of the world, it must be possible to distinguish different types, each of them practised under certain conditions.

This problem of the classification of types of agriculture has already been attacked several times and from different points of view.

Chevalier gave a system, which he called a bio-geographical one. He points out that ecologists do not seem to take much notice of cultivated plants and of the influence of culture on native vegetation. But in every part of the world a very large part of this vegetation has been supplanted by another: either cultivated plants or secondary formations occupying land that had been planted before with one kind of crop or another. He recalls the fact, that the so-called virgin forest of Central Africa is not virgin at all, but largely of secondary formation. Chevaliar concludes his introduction by saying, that in a general way all systems of agriculture which are practised in different parts of the world are adaptations to the existing conditions of topography, climate and natural vegetation and also to the civilisation acquired by its performers.

A study based on this thesis might have produced an important contribution to agricultural geography. But in the classification following this introduction other lines of investigation are followed.

It is in accordance with facts to distinguish between herding and agriculture proper. This last is divided into two groups of systems: extensive and intensive. But with this distinction the classification of Chevalier is not based more on the adaptation to topographical climate and natural conditions, than on conceptions belonging to the domain of farm management.

Every system may be practised extensively or intensively and this is the cause of much confusion. So Chevalier places under the heading "extensive without use of draught animals" both the "rays" system and

* By M. B. Smits in *International Review of Agriculture*, Year XXII, No. 2, February 1931.

the periodical clearing of forest on behalf of one or two crops, and agriculture on terraces in the hill country of South-Eastern Asia. But the last often is a very intensive system although no use is made of plough or dung or artificial fertiliser. And tobacco culture on Sumatra plantations, which practise a very intensive system, is based on a short period of clearing, followed by a long fallow in which forest and brush occupy the ground for several years. Systems as different from an agricultural standpoint as Chinese rice culture, plantation culture of perennials, and European agriculture as practised in Denmark, Holland, Belgium, etc. are put together in one division, that of the intensive systems.

Ahrens in 1927 published a study in which he by classification of the agricultural systems tries to show the dependence of these systems on the surroundings in which they developed. According to Ahrens these systems depend on human and geographic conditions. As it is his purpose to show the dependence on the last mentioned, he tries to separate the two influences as far as possible. Therefore he based his study on the different types of landscape (*Landschaftstypen*) Passarges.

Ahrens gives a mass of information about agriculture as practised by native peoples of the tropics and sub-tropics. He arranged it according to the classification Passarges but brought a new principle into account. He divided the agricultural system into two groups, the first not making use of a plough and the second using the plough.

It is not to be wondered at that in these two groups, classified in relation to the landscape in which agriculture is practised, the most divergent types are brought together. Systems differing as much from one another as : primitive agriculture in temporary forest clearings, agriculture in inundation basins after the water has flowed off, grain culture in prairie regions, rice culture on terraced irrigated fields, and agriculture in desert oases, are all put under one heading as not using a plough. His classification becomes still more complicated as he also takes into account in which time of the year crops cover the ground and so distinguishes between : rainy season—dry season—and summer farming and farming the whole year round.

But, does it make any difference in the practice of farming or in its underlying principles, if a forest plot is cleared in the dry season and planted with rice in the next wet one, or by lack of dry season in an arbitrary part of the year ?

Also Eckardt and Wohltmann are aware of the influence of natural conditions on the character of agriculture. But the former pays very much more attention to the different agricultural plants and their adaptability to different conditions, than to the agricultural systems of which they form a part. And Wohltmann tries to give a valuation of tropics and sub-tropics according to their productive capacity and classifies them according to rainfall. But he does not indicate how farmers in these different regions managed to get their systems in accordance with it.

When agriculturists have given descriptions of farming of certain areas these have been almost always of limited extent. And although agricultural practice in such areas does not differ so much as in remote parts of the world, they always succeeded in showing the relation between agricultural practice and its surroundings. Many brilliant studies of French, German, and American agronomists show the possibility of a study of this subject based on agricultural principles, and recent English publications on agriculture in the British Isles prove it again. These studies are not concerned with the influence of climatic and other environmental factors on different crops but with the practice of farming and its adaptation to environment.

Agriculture cannot be divided according to a simple set of complementary properties; it is too complicated. It is therefore necessary to ask in the first place, what is the most characteristic farming practice.

It may be asked if it is of more than theoretical value to discuss the question of farming systems. Instead of discussing the question at length it will be better to give some quotations from a report of Stockdale on agriculture in Sierra Leone.

After having given a description of existing conditions Mr. Stockdale remarks: "Sierra Leone can be pictured as a country passing through those evolutionary phases which similar wet and undulating countries in the East must have gone through in the eariler stages of their history. Cultivation of rice is passing from the hilly lands after exhaustion to the lower swampy areas. The latter cultivation is the more permanent and should be encouraged. The cultivators can be assisted greatly by lessons which can be translated from the East and it seems very desirable that matters concerned with drainage, terracing, cultivation and regulation of water should be investigated in Sierra Leone." . . . . "Sierra Leone has an indigenous high land coffee, which is of good quality. Liberian coffee does well and the growth of Robusta types is promising. More has to be learned, however, in regard to the cultivation of the latter coffees in Sierra Leone, as such questions as shade requirements and the treatment of the soil have not yet been fully investigated."

In the first quotation Stockdale expresses the idea that experience of Oriental farmers may be of use for Sierra Leone. The lessons of the East should be translated into West African language, that is to say, it should be investigated how far the Oriental farming system could be applied in West Africa and what adaptation to the new country would be necessary. Stockdale does not speak about an investigation of rice, or peanuts, or irrigation, or ploughing, but about a certain farming system of which those other subjects form part.

But to start such an investigation, to translate the lessons from the East, it is necessary to know that Eastern system, to know what characterises it, to know the language of the East.

Stockdale is quite right in borrowing from the East and not from Europe. Europe too is rich in experience, but its experience is of small value for West Africa. It is from the East that the lessons have to come.

It might be useful to point out a difference between the ideas expressed by Chevalier and the advice of Stockdale. In the classification of the former there is place for a "complete system", in which plough, draught animals, fertilising of the soil, etc. have found their place. European agriculture has been the standard by which other systems are measured, being regarded more or less as the ideal system. Stockdale's advice is based on the idea that there is no such thing as an ideal or a complete system. There are several systems, which are of the same value, and each of them may be complete in itself.

The second quotation in regard to coffee-growing does not mention the lessons from the East, but concerns investigations in relation to shade and soil management. However, it is not European agriculture that will be able to give advice in these matters. Perhaps experience gathered in the practice of tropical plantation agriculture may be of value in this case. But this experience has not much in common with that of the farmer of the Orient. It is another system, differing from Eastern agriculture as well as from European, that will find a place on the hills of West Africa. These few quotations may suffice to show the practical importance of the question of agricultural systems.

Wherever man occupies himself with plant production, either for direct use or to be converted into animal products, his labour and efforts are directed to the establishment of a crop and to the protection of that crop against anything unfavourable to it.

It may be that adverse conditions predominate and that it will not be possible to gain a livelihood in this way. The only method by which it may be gained is then to take the natural vegetation and to convert it into animal products. The aim of the stock farmer is to get sufficient grazing grounds for his cattle and to protect them against adverse conditions.

Both classes may live together in the same part of the country, the arable farmer occupying the localities more favourable to plant production.

It may be that the arable farmer makes use of animals to facilitate his labour, to make it possible to plant a larger acreage, or to get better crops from the same acreage. It may also be more profitable to turn his produce either partly or entirely to his cattle. But this makes no difference in principle: this farmer is occupied first and foremost with crop production.

It may be profitable to the stock farmer to produce crops, to provide food for his cattle when nature does not produce sufficient, and to protect in this way his stock from heavy losses.

Economic and social conditions may change so that it will pay to have more cattle on a certain acreage or more productive cattle, and this may induce the stockbreeder to occupy himself with native vegetation, to ameliorate it and to make it productive.

There is a tendency under certain advanced social and economic conditions to make stock-breeding profitable to the arable farmer and to force the stock-breeder to occupy himself with crop production. The result is that a class of men, formerly not interested in crop production, or only to a less extent now, also becomes interested in it.

The development of agricultural machinery has made it possible to gain a livelihood by crop production where it was impossible to do so before this machinery existed. Large acreages formerly only adapted to grazing are now in use for grain production. Yield per acre is low and uncertain and the old implements did not permit a man to cultivate a sufficiently large acreage to subsist on. New machinery made it possible for the same man to plant a large multiple thereof. And so grazing land formerly only occupied by the stock-breeder has now been added to the grain fields.

But all these alterations have not changed the principles of crop production. Different plants may be cultivated or plants may be grown where they were not before; simple implements may have been supplanted by more complicated machinery, thus enabling men to produce more in the same time, or to do the work more efficiently; the aim is the same to bring the soil into such condition that the plants will thrive and to protect them against adverse conditions.

It has no influence on the growth of plants if the soil is brought into that condition by hoe, or spade, or plough; or if that plough is drawn by animals or tractor. Nor has it any influence or production if weeding is done by hand or by the use of implements or machinery. The only thing that matters is the condition of the soil and if man has succeeded in his endeavour to provide the best condition.

Every farmer knows by experience that yields diminish after his soil has been planted for a certain time with a crop or a succession of crops. This is put down to the soil and it is said that its fertility has diminished. Everywhere one tries to restore that fertility by one means or another. These measures to maintain the productivity of soil form an essential part of every system of agriculture.

We may say therefore that agricultural systems are characterised by:
(a) the condition into which the soil is brought to produce a crop.
(b) the method used to restore, maintain or improve its productivity.

FACTORS OF QUALITY IN COPRA*

WELL-PREPARED copra is white, of low moisture content and brittle, the pieces of copra being of good size and without "smalls". The meat is of good thickness and has a high oil content. If these conditions are satisfied, the copra will arrive in Europe insect and mould free, white and sweet.

Colour.—Besides yielding a colourless oil, white copra also yields a light-coloured cattle cake. Caramelised, superficially burnt, or black copra yields an oil of varying redness which may in some cases be only partially bleachable and a cattle cake which the farmer will reject on appearance and perhaps also because of the smell of associated distillation products from the drying fires. It is also suspected, but not yet confirmed, that insects are especially attracted by slightly burnt copra, particularly where cell rupture has occurred.

Moisture.—Wet copra is the standard product bought by the local dealers in native copra because at certain seasons of the year—notably in November and December—it is impossible to sun-dry copra satisfactorily in this country. During the day the air is about 79 per cent saturated with moisture, while at night the relative humidity averages 95 per cent. Apart also from seasonal fluctuations, humid days and relatively dry days alternate irregularly so that it is impossible to work on standardised lines in order to obtain a standard product either by sun-drying alone or by kiln-assisted sun-drying. Careless preparation therefore, becomes the rule and local dealers adjust their prices accordingly.

In table I, certain records are given relating to the atmospheric conditions existing in an important coconut district and from these figures an approximate estimate may be made that in the most humid month it takes four times as long to sun-dry copra as during the driest month, while on certain days it will be quite impossible to effect any drying. Thus in the month of November, a piece of wet copra (moisture about 50 per cent) was exposed in the sun for five days by which time it still contained 35 per cent of water and was heavily covered by a multi-coloured mycelium of copra moulds.

To make matters still worse, there is the added factor of heavy moisture generation when such badly prepared native copra is stored under unsatisfactory conditions (see later).

Table I

Atmospheric Conditions on the Selangor Coast (Bukit Jeram)
1929 Mean Hourly Values For Relative Humidity (Day)

Hours	9	10	11	12	1	2	3	4	5	6
July	78	74	71	68	68	67	67	69	70	74
November	86	81	75	74	74	75	76	79	83	88

Mean Values

	Day (10 hours)	Night (14 hours)	24 hours
July	71	88	81
November	79	95	89

	Hours of strong sunshine (daily mean)	Strong windy days
July	8·5 hours	1 day
November	6·4 hours	3 days

Relative Drying Power of Air (Shade)
Assume no drying at about 80 per cent humidity

	Day	Night	
July	96 units	0	
November	27 units	0	(? with moisture re-absorption)

* By F. C. Cooke, A.R.C.S. B.Sc., Chem. E., in *The Malayan Agricultural Journal*, Vol. XIX, No. 3, March 1931.

At this stage the related question of moisture re-absorption might be considered. While it is claimed for the Philippines that 5 per cent moisture represents approximately the stable moisture content in copra there, the Malayan figure depends on the time of the year and, of course, on the structure of the copra. A skinned over or "case-hardened" copra will naturally take up moisture more slowly than a uniformly dried piece of copra (see later).

It has been found that during the dry season, copra can be dried to 4 per cent moisture content and will remain dry and that wetter copra will on very prolonged storage under good conditions continue to dry out to this figure. In the wet season, similarly well-dried copra will, however, re-absorb moisture slowly to between 6 per cent and 7 per cent for "case-hardened" copra and even up to about 10 per cent for copra which has not a protective skin. About 6 per cent represents the average stable condition of kiln-dried copra stored in bulk. It would materially assist the welfare of the industry and simplify the handling and marketing of this commodity if this figure were adopted as the standard by all producers.

During transport to Europe, all the copra produced in this country dries further and almost invariably on arrival at its destination the moisture content is between 4 per cent and 5 per cent.

To allow for moisture loss and possible deterioration of quality in transit, the usual practice is for the shipper to claim a weight allowance of about 5 per cent whether such a loss occurs or not.

Copra Deterioration.—A copra of satisfactory moisture content, (viz. 6 per cent), is liable only to the formation of a thin white mould which readily falls off in transit, leaving the copra clean and white on arrival in Europe. Copra of higher moisture content produces white, brown, green or heavy black moulds apparently indiscriminately with the development of heat, free acidity, rancid odour and internal darkening of the material. Black mould in particular is indicative of copra with a moisture content in excess of 10 per cent. The factors which determine the development of specific moulds are in course of determination as it is fairly certain that the moisture content is more an agent than a controlling factor.

It is specially intreresting to note that the process of decomposition adds moisture to the copra so that when bad copra is stored in ill-ventilated store rooms or transported in leaky boats, the quality may easily become progressively worse and result in a hot, slimey, dark, evil-smelling, matted product of high acidity but with a high oil content (see table III and later).

Two samples of copra were stored for two months in sealed tins with the following results :

Description	Original moisture per cent.	Final moisture per cent.	Description
White, crisp	4·5	5·4	F.M.S. quality maintained.
White	12·1	64·7	Rank smell. Black, congealed and rotten.

While such slimey copra is of no value of export purposes, it is sold locally at a cheap price and commands a ready sale to certain Malayan oil mills. It is important to explain why such copra contains a high percentage of oil while at the same time heavy losses are incurred during the process of deterioration, both oil and copra being converted to water vapour and gas and lost.

Oil Gradient.—When slices are cut from pieces of coconut meat parallel to the testa or brown skin and the different slices are analysed, it is found that an oil gradient exists in the meat which in the case of ungerminated nuts is practically marked. The figures in table II serve to illustrate this point.

Table II

Oil Gradient in Coconut Meat

Nut Selected	Oil Percentage (dry basis). Slices of equal thickness					
	1	2	3	4	5	Testa
Ripe brown nut	40·0	64·6	67·2	75·8	73·7	13·8
Ripe (1 in. haustorium)	52·0	68·2	72·8	76·0	76·4	—
Overripe (4 in. haustorium)	—	73·8	70·2	74·5	74·5	—

Table III

Copra Deterioration. To illustrate the relation between high free fatty acid (f.f.a.) and high oil percentage.

		Good undeteriorated copra	Insect ridden copra	Mould and insect ridden
Malayan	No. of samples	16	2	8
Estate	Average oil percentage	65·8	65·4	66·8
Copra	Average (f.f.a.) percentage	·1	·2	·8
Straits	No. of samples	6	7	19
Native	Average oil percentage	64·8	65·2	67·0
Copra	Average (f.f.a.) percentage	·3	1·2	1·6

Thus, when moulds attack the inside face of a piece of copra, it would appear as the tissue containing the lowest oil percentage is broken down and removed in the form of gas and water vapour and the unattacked copra that remains becomes progressively richer in oil. As deterioration progresses (in the absence of insect attack) the average oil percentage therefore increases and figures in excess of 70 per cent oil for low grade Malayan copra are quite common. Only in very exceptional cases is the percentage of oil lower than 66 per cent in mouldy Malayan copra, i.e., when copra is uniformly rotten throughout.

During such deterioration, free acidity and the further destruction products of glycerol render the copra sour and evil-smelling and the resulting oil and cattle cake are dark and unpalatable.

However, it is important to note that the ether extract includes the free fatty acid so that deteriorated copra does not contain as much neutral oil as analytical results expressed as oil percentage (dry basis) may appear to show. The importance of this observation lies in the fact that the purification of an extracted coconut oil to remove its free acidity yields in large quantities what is known as "dirty soap stock" and in an edible oil factory the disposal of this bye-product is difficult, while in the soap factory it can only be used in low grade soaps, because it retains most of the dirt and colour of the oil. This soap stock is not of much value and its removal by caustic soda is expensive.

During deterioration by heat, moulds or insects, there is a concealed loss of oil and copra constantly proceeding which may be very considerable. It is the producer who suffers from these causes, because the various buyers allow in the price they are able to offer for anticipated depreciation in transit.

The actual loss of oil and copra occurs during deterioration has been shown experimentally in Fiji by exposing copra on a drying "Vata" to the action of air-borne moulds. In 14 days it was found that the copra dried to 5 per cent but that it lost 12·4 per cent of its anhydrous weight and 8·2 per cent of its total oil, while the free acidity rose from ·2 per cent to 8.5 per cent.

It has been found in Malaya that if bad copra, which has developed a high degree of rancidity, is stored under good conditions of free ventilation, the acidity diminishes while the copra as a whole will become dry and clean and the mould will fall away as dust. Six large samples were stored for three months under excellent conditions and the results are given in table IV.

It would appear that the drying of the copra arrests further acid formation from the neutral oil, while the existing fatty acids are converted into water vapour and gas and removed with a consequent reduction in the (f.f.a.) content.

Table IV

Effects of Storing Native Copra

Date of Receipt : 28-12-29

Original Appearance			Acidity of oil per cent (as lauric acid)			Final Appearance
			30-12-29	28-2-30	18-3-30	
Light brown	Mouldy	Superficial insect attack	·72	·42	·42	All the copra now dry and mould free but exceedingly insect-ridden—originally the samples looked different, now they look similar.
Light brown	Mouldy	Superficial insect attack	1·72	·43	·22	
Dark brown	Very mouldy	Insect-ridden	2·48	1·82	1·51	
Dark brown	Very mouldy	Insect-ridden	3·02	1 21		
Dark brown	Very mouldy	Insect-ridden	3·12	1·76	0 80	
Dark brown	Very mouldy	Insect-ridden	3·43	2·15	2·04	
	Average		2·42	1·30	1·12	

Neutral Oil

Fatty acid	Glycerol
Gas and Water Vapour	Glycerol Derivatives Gas and Water Vapour

Physical Properties.—Apart from its good keeping qualities, well-dried brittle copra is to be preferred because, as has been stated by an authority in England, rubbery copra does not press well. When the pressure is applied the oil flows satisfactorily, but at the end of the operation when the pressure is released, the cake tends to suck up the oil again owing to the elasticity of the material. This authority has stated that with such copra it is not possible to reduce the oil below 7 per cent, whereas good friable copra yields a cake with 5 per cent oil.

Such rubbery copra may be produced from young nuts, and "case-hardened" copra with a wet core will also show elastic properties. It is interesting to note that "case-hardened" copra appears to show considerable resistance to mould attack except in the presence of insects which are able to pierce the burnt crust and so expose the wet copra beneath to mould attack.

Size.—If the pieces of copra are too large, the consignment will naturally be very bulky, and the best practice is to chop the half nuts into four pieces. The manufacturers object to copra of large size on the ground that it takes longer to charge the machinery and more storage room is required owing to the bulkiness of the material.

At this point some reference might be made to the advantages of baling chopped copra. To date, one firm in this country has exported during the past year 500 tons of "F.M.S." copra in baled form to Europe with entirely satisfactory results. An article on this subject giving the experimental results obtained has already been published and further experimental work is proceeding to explore the possibilities of the baling of the lowest grade of copra available on the Singapore market.

It should be noted (a) that copra can be compressed at a pressure of 1·5 cwt. per square inch without loss of oil either during compression or subsequent storing and shipment. (b) That the "broken stowage" is reduced, e.g., 20 cwt. of baled copra occupies only the same cargo space as 12 cwt. of sacked copra. Local transport and shipping freight charges can accordingly be reduced. (c) The bales stock squarely leaving straight channels for air movement through the stack. (d) The bales, which are 2 cwt. in weight, can be easily checked and are of convenient size and shape. (e) There is no evidence that "F.M.S." copra deteriorates more in transit in baled form than in sacks, nor is there any loss of oil.

If the material is much broken up so that there are "smalls" the dealer objects because:

(a) This allows the careless or deliberate inclusion of foreign matter, (grave exception is taken to sand, nails, etc. which can do great damage to machinery).

(b) It makes sorting of "mixed" copra into "F.M." and "F.M.S." grades difficult.

(c) Much broken up copra exposes a large surafce to mould and insect attack and the smallest pieces are gradually converted to a grey fibrous dust which gives the material a dirty appearance. The small pieces are also readily lost in handling.

(d) The cattle cake derived from such copra will be sour and darker than the best.

The production of "Smalls" should, therefore, be avoided and it is recommended that, where the meat must be extracted wet from the shell in the field, as far as possible only fully-ripe nuts should be harvested. The meat of unripe nuts is very adherent to the shell, while the thin meat of very overripe nuts is inclined to break. On the other hand, where the halved nuts are transported to the kiln and are subjected to semi-drying, the half pieces of meat readily fall out of the shell. When the fully-dried copra is subsequently chopped to reduce the bulk, care must be taken to obtain pieces of even size. It is doubtful, however, if this practice is to be recommended as a fresh wet surface is thereby exposed to mould attack. It would be better to chop the copra when half dry as it comes from the shell and then dry and seal the cut surface.

Thickness.—As far as possible, only fully ripe brown nuts should be used for the production of copra because such nuts produce the greatest thickness of dry meat. The practice of picking unripe nuts in order to take advantage of a favourable market, or to obtain a speedier cash return, or because crop collection is leased out, or to anticipate theft, is well known.

Oil Content.—It has been shown that bad copra can contain a high percentage oil content, i.e., high ether extract. At the same time the yield of neutral oil will be small and it will be of low quality on account of extraction difficulties. A large amount of soap stock has to be removed to purifiy the oil, while much of the original colour and odour is still retained in the oil even after refining.

The ultimate objective is to produce a copra equivalent in physical condition, appearance, and oil content to the "F.M.S." Ceylon product. In Ceylon a white copra of high oil content is regularly produced, and receives special preference in the London market. The related questions of cultivation and soil impoverishment are being investigated, while correct nut harvesting and possible oil loss during copra preparation are also being studied with a view to correcting the alleged decline in the oil content of good quality Malayan copra during the last ten years.

SOME FACTORS IN COFFEE CULTIVATION*

Influence of the Acidity of the Cultural Medium on the Coffee Tree.—About the influence of the acidity of the soil on the growth of the coffee tree we are wholly ignorant. The first indications about the requirements of coffee in this respect have been forwarded by the experiments of De Camargo, who cultivated young coffee plants in water cultures of different hydrogen-ion concentration.

As previous experiments had shown, it is possible to cultivate Arabian coffee (*Coffea arabica*) for more than one year in spring water containing 0·0196 K; 0·04 Ca; 0·023 Mg; 0·005 SO_4; traces of H_2PO_4; 0·004 NO_3 and 0·011 Cl. In the new experiments sulphate of potash and sulphuric acid were added in different doses so that the cultural solution got hydrogen-ion concentrations of 7·2, 6·8, 5·8, 5·1, and 4·2. After 7 months' growth the weight of the plants, grown in these solutions of different hydrogen-ion concentrations was measured and it was found that the plants grown in the solutions with hydrogen-ion concentrations of 5·1 and 4·2 had obtained the highest weight.

The conclusion may be drawn that *Coffea arabica* prefers a medium of high acidity. It may be expected that the same will be the case with Liberian and robusta coffee and also with other cultivated coffee species. We may remember that the para rubber tree grows well on acid soil with a hydrogen-ion concentration of 3 to 6.

Soils which are suitable for coffee are in general suitable for rubber —in fact the two crops are often grown in combination.

Manuring.—A fertiliser experiment in Porto Rico seems to indicate that on the soil in question a beneficial effect was obtained from potassium manure, especially when combined with nitrogen. The fact that the experiment contains only one series of plots and that each year the arrangement of the plots was modified makes it difficult to draw a definite conclusion. The author considers that in Porto Rico "the application to fairly good coffee of 100 pounds of ammonium sulphate and 200 pounds of potassium sulphate (or potassium chloride) per acre at six months' intervals should bring to the coffee planter handsome returns on his investment in fertiliser." It seems however that further experiments will be needed to give a reliable basis for such a statement.

Selection.—At the Pacific Science Congress, which took place in 1929 in Bandoeng (Java), the question of the selection of perennial crops was one of those discussed. A preliminary report of the paper of Dr. Hille Ris Lambers was given by Ir. Ostendorf.

In Java coffee selection was carried out on one plantation (Banaran) under scientific guidance and in three Experiment Gardens, viz. (1) "Bangelan", the Coffee Experiment Garden of the Agricultural Department, (2) "Soember Assin", the Experiment Garden of the Experiment Station, Malang and (3) "Kaliwining", the Experiment Garden of the Besoeki Experiment Station.

The system in "Bangelan" has been to select superior mother trees and to test the illegitime descendants, (i.e. the descendants obtained by uncontrolled pollination). When a mother tree produced in this way descendants of superior quality, the mother tree was kept for seed winning and

* From the *International Review of Agriculture*, Part I, Year XXI, No. 11, November 1930.

in some cases little fields were planted with grafts of the mother tree in order to obtain a larger quantity of the seeds. Only robusta coffee has been made the subject of a thorough study. In Bangelan the question of the stock has also been studied and it was found that the seedlings of different trees were not all equally suitable for being used as stocks. One hybrid of robusta and Quillou was considered to be exceptionally suitable.

In "Soember Assin" a great number of small fields have been planted with seeds and with graftings of superior mother trees. As far as possible the seeds are obtained by means of self-pollination of the mother tree. Artificial cross-pollination with different mother trees have also been made. The characters which are especially kept in view are: high-bearing power, large beans, and resistance against leaf disease, and berry borer.

In "Banaran" similar lines are followed. Here also mother trees have been selected which excelled in high-bearing power, good quality of beans and resistance against disease, and of each mother tree one or more fields of grafted trees and one field with seedlings—obtained by self-pollination—have been planted.

In "Kaliwining" the same scheme has been followed.

In the discussion which followed after the reading of the papers, it was pointed out that the selection work with coffee had not yet shown the great practical success which the rubber selection work had obtained. One of the greater difficulties in the selection of coffee was according to Ir. Huitema the small amount of graft material that could be obtained from one tree.

Planting System and Shade Trees.—For many years the "dadap serep" (*Erythrina lithosperma*) has been in the Dutch East Indies the generally used shade tree. In consequence of the attack of different diseases and pests (especially of the cicadellid *Typhlocyba erithrinae*) it could no longer be used and was replaced by the "lamtoro" (*Leucaena glauca*). However, neither this nor any of the other leguminous trees tried as shade trees was considered to be equal to the old "dadap." It has therefore been endeavoured in different ways to use the "dadap" again, be it in combination with the "lamtoro."

A new scheme for using the dadap in combination with the lamtoro was proposed by Rudin. This scheme is based on the consideration that the dadap cannot be relied upon after its 8th year, therefore every eight years the dadaps are entirely replanted. This is done in such a way that one half of them are replanted in the 7th year and the other half in the 8th year.

Thus one row of coffee alternates with one row of shade trees, and of the rows of shade trees we have alternating one row consisting of only lamtoro trees and one consisting of lamtoro and dadap alternating. The coffee is planted at 10 by 10 feet, and in the rows of shade trees these are also 10 feet apart. In this way the shade trees are planted very closely, but this is done purposely to make them serve also for the production of fuel, and for this purpose the lamtoro is regularly pruned, while as mentioned, the dadap is replanted after 7 and 8 years. The pruning of the lamtoro is done in this way: every year one-third of the lamtoro is cut back up to 10 feet and in the 3rd, the 9th, the 10th, and the 11th year about one-fourth of all the lamtoros are replanted.

The only drawback of this system seems that it is rather complicated, but the principle to use the dadap in combination with the lamtoro by rejuvenating the dadap every 8 years seems very sound.

The writer also gives a scheme of improvement of the soil conditions by means of a system of pits which are dug between every two shade trees. The system is so that every four years the same pit is dug out again, and in each of the consecutive four years the pits are dug in another place.

A detailed calculation is given of the expenses of the application of this system of shade trees and pits.

Preparation.—An elaborate description of the preparation of robusta coffee in the Netherlands Indies, resulting from an enquiry in which 149 estates collaborated, was given by Knaus.

A minority of the estates use water power, the majority use motor power or steam engines.

As regards the pulping machines the "Vis" pulper has practically ousted all the other systems. (Walker pulper, Gordon pulper, etc.)

Fermentation and washing is done in many different ways. Fermentation time varies from 12 hours to 8 days. It seems desirable to investigate what system is the best and to bring more uniformity into the different methods. On 19 estates fermentation has been entirely eliminated. At any rate it is at present clear that fermentation has no influence on the taste and the colour of the coffee. A too long fermentation can, however, have a deleterious effect.

The most practical washing machine, which is especially recommendable when no fermentation is applied, is the "Rapido" washing machine. It consists of a double perforated trough, in which two horizontal spindles with paddles are rotating. When fermentation is eliminated washing is done on same estates with the addition of lime or ash. This furthers the removing of the pulp. The drawback that beans with a damaged seed skin gets a dark-bluish discoloration makes this method not recommendable.

A new method of fermentation has been tried with success: This consists in fermenting under a slow continuous stream of water. The beans are lying on a perforated plate and water is continually added. In this way the substances which are formed during fermentation are quickly removed and the fermentation is accelerated so that it is completed in less than 24 hours..

When the coffee leaves the washing machine it contains about 55% of water. On the great majority of estates the first drying is done in the sun on drying floors or on a draining floor, or a centrifuge is used. Only on a minority of the estates the coffee is at once brought into the drying house. On the drying floors the water percentage can decrease in one morning to about 35%, if the coffee is spread out in a thin layer; on the draining floor the water percentage goes down to about 50% and in the centrifugal machine to 45%-50%. The higher cost of centrifugal machines makes them not recommendable.

Of the various systems of drying houses the Vis system is the most extensively used. Drying in the drying house is perhaps the most important part of the preparation, and the quality of the coffee depends on it for a great part. A drying house is considered to be practically indispensable. On 3 out of the 149 estates no such houses are used: 2 of them dry wholly on drying floors in the sun—a process which takes one week or more—and on one estate a Guardiola drying machine is used. Otherwise Guardiola machines are no longer used on account of their small capacity.

For details of the Vis drying house reference must be made to the original article which gives a scheme of this system. According to the capacity of the house and the quantity of coffee to be dried, drying can be done in a quicker or in a slower tempo. On the majority of the estates the coffee is ready after having been kept for 24-25 hours in the drying house. On some estates the coffee remains in it 48 hours. The temperature is on the majority of the estates in the beginning 90-100°C. dropping gradually to 50-60°C. The coffee must regularly be turned over.

When the drying is complete the coffee must be broken either with the teeth or with a hammer and may not be dented.

The tempo of drying influences the colour: slow drying gives a dark-green or even a bluish-green colour, quick drying at a high temperature gives a light colour (yellow-greenish to yellowish). The most desirable colour is obtained by drying at an initial temperature of about 100°C. which is made to drop about 50°C, a greenish colour is obtained in this way and the silver skin gets easily removed, which is not always the case when the coffee is dried slowly.

As to hulling, the Engelberg huller is generally used.

Sorting machines are in use on 46 estates, mostly the Gordon thread-separator. The author considers that better sorting arrangements should be aimed at.

The following figures show the loss in weight of 100 kg. fresh ripe berries during different manipulations:

Fresh ripe berries	100 kg.
Pulped	74 ,,
Washed	52 ,,
Centrifuged	47-49 ,,
Dried on drying floor	44 ,,
Dried in drying house	26 ,,
Hulled	22 ,,

THE MALARIA PROBLEM OF ASSAM*

IN an address on the control of Malaria in Assam, delivered to the Assam Branch of the British Medical Association in January, 1930, I recorded the principal results of my researches, during the past four years, on Assam's malaria problem. From my researches I stated that *A. minimus* was practically the only carrier found among some 50,000 adults dissected belonging to twenty different species. I also recorded the results of my investigations on the bionomics of this species. I stated that in the selection of its breeding places, *A. minimus* in Nature avoids: (1) Contaminated water. By that I mean muddy or silty water; water with finely divided clay in suspension; water contaminated with the products of iron oxide bacteria; or water covered with a thick scum of surface algae. (2) Water which has a high velocity of current. (3) Water covered with dense shade.

I also recorded that the conditions which this dangerous species selects for breeding sites are: (1) Clear water. (2) Stagnant or slowly movinig water. (3) Where a certain degree of sunlight reaches the water surface.

MASONRY WELLS

To the types of breeding places of *A. minimus* which I have already recorded, I have now to add finding larvae of this species in a "pucca well." The "pucca" well in which *A. minimus* larvae were collected was about 20 feet deep, and was constructed entirely of reinforced stone concrete well-rings cemented together to prevent contamination of the water from percolation. The water level in the well was within six feet from the ground surface. This finding, at first, appeared to me to be exceptional, but the necessary condition demanded by *A. minimus* in the selection of breeding sites, viz., clear, uncontaminated, slowly moving or stagnant water, completely or partially exposed to sunlight, were fulfilled.

The main reason why *A. minimus* and other species of anopheline mosquitoes have not previously been found breeding in masonry-built wells fulfilling the above conditions in areas which I have investigated is doubtless due to the fact that these wells are usually treated daily with chlorogen, thereby eliminating the larval food supply. Further, mosquito larvae have little chance of surviving even in open unchlorinated pucca wells, as water is being more or less continually withdrawn by buckets from early morning to late in the evening. The well teeming with *A. minimus* larvae had, I found on investigation, been left unchlorinated and undisturbed for several weeks. *A. minimus* has now been eradicated from this well by eliminating the light factor, i.e., by providing a suitable cover. This fiinding in a masonry-built well clearly demonstrated to me that concrete inverts, unless properly graded and constructed, could also function as breeding places for *A. minimus*. As mosquito control by "pucca drains" was the principal anti-malaria measure adopted in a highly malarious site in Assam, I was interested to learn that many of these drains have also to be regularly oiled because anopheline mosquitoes are found breeding in these concrete inverts. An engineering friend, who has studied the anti-malaria measures which have been carried out in areas under my supervision, wrote to me that "open pucca drains with slopes flatter than 1 in 400 do not keep dry, as slight settlement and imperfect work cause pools to form. At 1 in 400

* By Dr. G. C. Ramsay in *The Journal of Tropical Medicine and Hygiene,* No 23, Vol. XXXIII, December 1, 1930.

they are fairly free from pools. Again, all pucca drains have to be cleaned regularly, as rubbish causes pools." It is obvious that, if concrete inverts are to fulfil the function intended, the factor underlying mosquito control by this means is to obtain high velocity of current by eliminating pockets, pools, obstruction from vegetation, and to provide a suitable gradient. In my opinion the gradient should not be less than 1 in 200.

WATER TIDINESS

The removal of vegetation, i.e., the clean weeding of drains, streamlets, streams, pools and tanks has been repeatedly advocated in Assam and elsewhere as an anti-malaria measure. The principles underlying clean weeding or removal of debris which are of value in preventing mosquitoes breeding are: (1) increase of velocity of current through removing obstructions; (2) in certain types of soil there is increased water contamination from the direct action of the water on the denuded soil surface (silt or clay factor); and (3) in other cases and especially in pools and tanks the removal of vegetation diminishes the available shelter for larvae and increases the opportunites of larvivorous fish. But my own experience has been that *A. minimus* will breed freely in the small pockets and bays of clean-weeded, clear water, slowly running drains, streamlets or streams, also in clean-weeded pools or tanks if the degree of light, demanded by this species in its breeding areas, is sufficient. In high-lying hyperendemic malarious sites the slow flowing clear water in loops, pockets and pools of partially shaded or unshaded streams and streamlets affords prolific breeding places of *A. minimus*. These areas are frequently devoid of any vegetation (grass or weeds) near the water edge. It is apparent therefore that clean weeding as an anti-larval measure has decided limitations, especially as thorough oiling by a knapsack sprayer destroys vegetation. Further the decomposing vegetation is an excellent medium for retaining oil.

In most tea estates in Assam it is routine custom to clean out ditches and drains periodically from the point of view of tea cultivation. The principle underlying cleaning drains is obviously to prevent water logging, or in other words to increase soil aeration by facilitating run-off. The result of these cleaning efforts, unfortunately, has been in many cases to broaden water channels unnecessarily, and thereby to reduce the velocity of current also to increase the difficulty of providing biological control of malaria by dense shade.

SHADE

Where feasible, water channels on malariogenic terrain should be narrowed and deepened as this increases the velocity of current and facilitates covering by dense shade. Dense shade, of course, prevents vegetation from growing in the bed or on the banks of a drain or streamlet and hence obviates the necessity of cleaning these channels, thereby also eliminating the recurring expenditure associated therewith. During the past eighteen months I have been investigating the degree of shade essential to eliminate *A. minimus* from proved breeding places. I find that durantha (the thorny privet hedge) and eupatorium give excellent dense shade over narrow channels and have, so far, from my investigations, fulfilled requirements, but my recommendation to shade clear-water broad channels with trees such as *Cassia nodosa* or *Cassia javanica*, unfortunately limits itself only to certain types of breeding places. Cassia trees although they give dense shade are deciduous and hence will not fulfil the function intended over breeding areas which are malariogenic during the period of the year when the leaves have been shed. Cassia trees shed their leaves in March, April, and early May, hence these trees are only suitable for shading breeding areas which function as *A. minimus* resorts, during the monsoon season. In hyperendemic sites where malaria is being transmitted after

the night temperatures rise above 60°F. in March and April, it is essential, where feasible, to provide dense evergreen shade over water-courses which are selected by *A. minimus* as breeding sites during this period of the year. For this purpose I am at present carrying out experiments with trees which will give dense shade throughout the entire Assam malaria season. The jak-fruit tree (*Artocarpus integrifolia*) appears to be highly suitable for this purpose.

SWAMP VEGETATION

A clear distinction must be drawn between the planting of swamp vegetation and allowing a swamp to revert naturally to jungle. I have watched swamps in the process of reverting to jungle over a number of years, and during these years they have remained a deadly danger to all who lived near them. In parts of the swamp there is shade enough to retard the growth of larvae; but the shade was by no means uniform, and open spaces teeming with *A. minimus* existed. In the course of many years, the probability is that the whole swamp would be shaded over; but we cannot afford to wait this time.

The vegetation I am now planting consists of several swamp plants, which are not the end-product of reversion to jungle, but an intermediate stage. They propagate themselves rapidly when introduced, and as we know from practical experience soon blot out the sunlight and *A. minimus*, which requires sunlight.

In these hyperendemic sites the principle underlying absolute shade are also being applied; that is filling in functionless man-made drains, man-made clear-water tanks, and borrow-pits.

TEMPERATURE

I have previously stated (*Ind. Journ. Med. Research*, 1930) that during the period of the year (December, January, and February) when the night temperatures drop below 60°F. the feeding stimulus of anopheline mosquitoes and especially of *A. minimus* is inhibited.

With a view to reducing expenditure on larvicides I stopped all anti-larval measures on fifteen gardens under my supervision during the past season when the night temperatures had dropped below 60°F., but carried on, as usual, all anti-larval measures on three tea estates in the same district, so that the effect on the incidence of malaria could be compared on controlled and uncontrolled areas during the ensuing transmission period. Fifteen of the uncontrolled gardens included three hyperendemic sites, while two of the controlled areas were also hyperendemic sites. The results, so far, have shown that, if dangerous breeding areas are efficiently controlled by anti-larval measures during the period of the year, when the night temperatures rise above 60°F., it appears to be unnecessary to apply anti-larval measures during the non-transmission period of the year. Further investigation, however, is required to confirm this opinion.

SOIL COMPOSITION

The relationship between soil composition and the breeding of *A. minimus* has been of great interest to me during my researches. The importance of certain types of soil which cause water contamination and hence become free from *A. minimus* is clearly brought out in low-lying land in Assam. In studying drains, streams, and streamlets on high-lying land it is interesting to note that many of these channels which have dried up during the cold dry weather run silty during the first few showers of the North-West monsoon and then clear during the remainder of the rainy season. The silt in these channels is obviously mainly due to atmospheric action, during the cold dry weather, which causes soil disintegration. As

soon as the gross products of disintegration have been washed away the water in these channels again runs clear and forms ideal breeding places for *A. minimus*. On low-lying cultivated land the finely divided products of soil disintegration, which have been in the past and which in this changing universe continue to be carried down from high-lying to low-lying land, are easily stirred up by rainfall and are inimical to the breeding habits of *A. minimus*. During the cold dry weather of 1929-30 I carried out a series of experiments on a drain, about fifty yards in length, on low-lying land, which *A. minimus* had selected as a cold dry-weather resort, because the undisturbed water had become clear. The silt was stirred up in the centre of the drain by three of my establishment for two hours daily over a period of one week. This had apparently no effect on the number of larvae which could be caught in the clear-water pockets at the edges. These pockets were unaffected as the silt did not reach them, but when the pockets and grassy edges of the drain were stirred up for two hours daily over a period of a week it became extremely difficult to find a single *A. minimus* larva. The degree of silt, also of water contamination generally necessary to eliminate *A. minimus* requires further investigation as experience has shown me that *A. minimus* is sometimes compelled during the cold dry weather to accept types of breeding places which are avoided during the rainy season when there is a great increase in the number of more suitable breeding places.

RICE FIELDS

An extensive cold weather breeding area, formed by seepage from a plateau adjacent to a tea estate where the spleen-rate, in garden-born children, has never in my experience been over 6 per cent. has also been of great interest to me. This area is free from *A. minimus* during the period of the year when the soil is stilled and when under rice cultivation. As soon as the rice crop is reaped, in November and early December, the undisturbed exposed seepages teem with *A. minimus* larvae. Water contamination from silt during the rainy season and probably the shade of the thickly planted rice after the monsoon season appear to be the factors in keeping this area free from *A. minimus* until the rice crop is out.

Many of the swamps in Assam when cleared are harmless owing to their soil composition (silt or clay factors); but exposed clear-water swamps are invariably highly malariogenic. The danger of these swamps is in many cases further increased when railway embankments or bund roads cross them and retard the flow of the natural waters and so increase the bearing areas. Instead of the usual bund and narrow bridge or culvert, screw bridges or suspension bridges are much more satisfactory. Such bridges cause the minimum interference with nature, and facilitate the replanting of the swamp with aquatic vegetation that will ultimately completely eliminate sunlight and *A. minimus*.

Again in Assam there are thousands of acres of swamp where, owing to the composition of the soil, rice can be safely cultivated. But in other places, swamps are so deep, and of so little value for growing rice, that it is questionable whether it would not be better to abandon them, and move the people back a safe distance, which need not be far, as was shown by Watson's observations on flat land jungle in Malaya, and Christopher's on the Andaman Islands. Both these observers found that malaria was absent, or nearly so, in villages or estate cooly lines which were over half a mile from the breeding places of *A. umbrosus* and *A. ludlowi* respectively. Even if further research fails to show us more efficient methods of controlling anopheles than we now possess, we have always the above as a method to fall back on.

EFFECT OF MALARIA ON LABOUR

Investigation has shown me that malaria in Assam is the disease which is mainly responsible for reducing the efficiency of, also for depleting, tea garden labour forces. Experience has also taught me that it is the highly malarious tea estates which are mainly compelled to recruit labour. There are many tea estates in this Province which are practically free from malaria and which have not recruited labour for over twenty years owing to the natural increase in the population. I have been informed that annually over £500,000 is spent by the tea industry on recruiting labour to tea estates in Assam from other Provinces in India. Much of this annual recurring expenditure will doubtless in due course be saved by the tea industry when the malariogenic factors in each area are carefully investigated and appropriate anti-malaria measures applied.

SUMMARY

A. minimus, which is the main vector of malaria in Assam, was found breeding in a masonry-built well. This finding, at first, appeared to be exceptional but the necessary conditions demanded by *A. minimus* in the selection of breeding sites were fulfilled.

This finding also shows that *A. minimus* will breed in concrete inverts if these are not properly graded and constructed, i.e., mosquito control by concrete inverts is dependent on velocity of current. In the case of masonry-built wells the light factor has to be eliminated by providing suitable covering.

In certain highly malarious sites it is essential, if *A. minimus* is to be eliminated, to shade malariogenic water by trees which will give dense shade throughout the entire Assam Malaria Season.

MEETINGS, CONFERENCES, ETC.

BOARD OF AGRICULTURE

FOOD PRODUCTS COMMITTEE

MINUTES of the meeting of the Food Products Committee of the Board of Agriculture held in the Board Room of the Department of Agriculture, Peradeniya, at 2.30 p.m. on Monday, the 23rd March 1931.

Present.—Hon'ble Dr. W. Youngman, Director of Agriculture (Chairman), Messrs. C. Drieberg, A. A. Wickremesinghe, S. Pararajasingham, A. Ramalingam, C. A. M. de Silva, Gate Mudaliyars A. E. Rajapakse and M. S. Ramalingam, W. A. Udugama Dissawa, Rev. Fr. L. W. Wickremesinghe, the Entomologist, the Economic Botanist, the Divisional Agricultural Officers, Central, Northen, North-Western, and South-Western Divisions, and Mudaliyar N. Wickramaratne (Secretary).

Visitor.—Mr. L. S. Bertus, Assistant in Mycology.

The Chairman announced that letters and telegrams were sent by the following members regretting their inability to attend the meeting: Hon. Mr. A. Mahadeva, Messrs. H. L. de Mel, C. W. Bibile, E. C. de Fonseka, C. Muttiah, the Agricultural Chemist, Gate Mudaliyar G. A. Gunatilake, and Mudaliyars G. W. Gunaratne and S. Muttutamby.

The minutes of the meeting held on 4th August, 1930, were confirmed.

Before proceeding with the business of the meeting, the Chairman referred to the absence of two members who intended to lead discussions on certain items in the agenda and to the poor attendance at meetings in general, and said that if it was found that the interest of members was falling off, it would become necessary to ask Government to reduce the number of meetings for the year which was four, but he hoped that that would not be necessary and it would be possible to keep the Food Products Committee going up to the full number of meetings.

With reference to the minutes of the previous meeting, the Chairman informed the meeting that the Sub-Committee appointed to go into the question of the reports made by the Paddy Sub-Committees and to draft recommendations, submitted the following to the Board of Agriculture at its annual Conference held in October last, viz:

"In presenting to the Board of Agriculture, in Conference, the reports of the Local Committees, the Food Products Committee recommends, through the Sub-Committee appointed for the purpose, that a Commission be appointed by Government to enquire into, and make recommendations with regard to, the possibilty of increasing paddy production in the Island in the light of the information in the reports, and it recommends especial attention, among other points, to the following:

(1) Improvement of irrigation facilities so as to meet the needs specified in the reports.

(2) Organisation and co-ordination of the services concerned with the cultivation of paddy as Agriculture, Irrigation, Revenue, Forestry, Animal Husbandry and any others (here should be considered provision of pasturage and fencing).

(3) Tenancy conditions (consolidation of infinitesimal shares in land, alienation of new lands under such conditions as to prevent the system of infinitesimal shares, and the impediment of the existing share system of rental).

(4) The marketing question (credit, supply of seed paddy and manure).

(5) Anti-malarial and other public health measures.

(6) The improvement, where necessary, of means of communication.

(7) Provision of efficient drainage and flood protection, including the clearing of elas."

Mr. H. L. de Mel, a member of the Sub-Committee recommended the insertion of the words "at an early date" between the words "recommendations" and with regard to". Mudaliyar Samarasinghe signed the above recommendations with the following rider:

> "I subscribe to the above without implying thereby that I consider the suggested recommendations adequate action upon the reports."

Mr. Wickremesinghe added the following rider:

> "That elucation in village schools be in a decidedly agricultural trend and experimental paddy plots be provided for every village school."

The Chairman further stated that on the suggestion of Sir Herbert Stanley, the Board of Agriculture had agreed that the recommendations of the Sub-Committee of the Food Products Committee be accepted in the main. A Paddy Commission had already been appointed and had its first sitting. The terms of reference had already been published.

AGENDA ITEM 2
NOMINATION OF MEMBER FOR N'ELIYA DISTRICT

The Chairman announced that Mr. M. B. Wettewe, Kachcheri Mudaliyar, had been nominated a member of the Food Products Committee to represent the Nuwara Eliya Food Production Committee in place of Mr. C. B. Herat.

AGENDA ITEM 3
ENCOURAGEMENT OF EXTENSIVE GROWING OF FRUITS

The Chairman said that Mr. H. L. de Mel who was to move the motion standing in his name for discussion viz:

(a) to follow up the campaign for a more intensive growing of fruits;

(b) to organise a freer distribution of budded and grafted fruit plants for sale;

(c) the manuring of fruit plants with a view to obtaining the fruit out of season;

had written to him of his inability to attend the meeting and had forwarded a memorandum on the subject which the Chairman said he would not propose to read but would like to place at a meeting at which Mr. De Mel would be present. The Committee agreed to allow the motion to stand over.

AGENDA ITEM 4
ASSISTING THE PADDY COMMISSION

The next motion in the agenda submitted by Mr. De Mel viz:

> "What steps this Committee should take to assist the Paddy Enquiry Commission which has been appointed"

was also allowed by the Committee to stand over.

AGENDA ITEM 5

INCREASE OF THE DUTY ON IMPORTED RICE

The Chairman called upon Rev. Fr. Wickremesinghe to move for discussion the motion standing in his name viz:

> "That the duty of imported rice be increased to help the paddy cultivation which has received a heavy set-back owing to the present low prices of imported rice."

Rev. Father Wickremesinghe expressed a desire that that motion be referred to the Paddy Commission and that was the wish of the Committee.

The Chairman here explained the procedure adopted by the Paddy Commission in their working and suggested that a discussion of the subject might be useful to the Commission.

Rev. Father Wickremesinghe explained his motion and dwelt on the unprofitableness of the paddy cultivation. The price of local paddy had gone down to Re. 1/- per bushel owing to the low price of imported rice which was Rs. 10/- a bag and suggested that the local paddy production should be protected by the raising of the Customs duties on imported rice.

He contended that if the price of paddy were to fall further there was danger of paddy being put out of cultivation. Many a cultivator in the Hambantota District who had been cultivating paddy was now preferring chena cultivation. He suggested the raising of the import duty on a sliding scale in proportion to the fall in the price of imported rice so that the price of paddy would correspond to that of imported rice.

A general discussion took place in which the following took part: the Chairman, Messrs. Drieberg, A. A. Wickremesinghe, De Silva, Pararajasingham, Peiris, Haig, Gate Mudaliyar Rajapakse and Udugama Dissawa.

The Chairman in a lengthy statement explained the position of the paddy industry. He said that if a tax were to be levied on imported produce, it was generally necessary to fix a maximum rate for the article. In the event of any interference with a thing of this sort it was necessary that the whole industry should be strictly controlled. This was a drawback. The Paddy Commission would no doubt consider the possibility of an import tax.

The Chairman was of opinion that the world depression in many things was undoubtedly related to the price of cereals, the food of the main bulk of the world's population. The condition of things in Russia, he said, was one of the many disturbing factors operating in the markets of the world. The Chairman remarked that a matter that should be closely considered was whether the depression in the price of cereals, including rice, was of a permanent or temporary duration. The problem was the same in Siam, Burma, and other paddy-producing countries. The return from rice in Siam was quite insufficient to make it not worth while growing. The Chairman believed that the Burmese to some extent attributed the depressed condition of rice to the almost absent competitor among the few exporting firms. He did not doubt that a good deal of economic depression was due to the fact that industries were in too few hands. This was one reason for the depression in coconut products. He said that coconut oil was mostly used in the manufacture of butter but the margarine trade in the world lacked healthy competition being in the hands of only a few firms. The Chairman remarked that whether permanent or not, the depression in the price of paddy made it impossible to produce rice at a profit not only in Ceylon but also among the Burmese from whom Ceylon procured her rice. In such a case rice production in exporting countries

would stop and ultimately the pendulum must of necessity swing the other way. The Chairman remarked that if paddy were to go out of cultivation, something else would have to be grown for the subsistence of the people and what that was going to be was not easy to say.

Another important point to consider was whether Ceylon would see a great increase in the production of food grains or vegetables. One thing that the Chairman had remarked was that Ceylon was in the very extraordinary position of being perhaps the only civilized nation in the world that had no industry apart from agriculture and that her agriculture produced no product of an annual crop or pasturage. The Chairman expressed his anxiety as to what would be the economic result if there was a drop in the value of tea when rubber had gone and coconuts were going. The cash coming into the Island would then have decreased considerably and the fate of Ceylon was to be seen, a country not producing enough food for itself nor any commodity apart from those three plantation products that it was sending out with which to derive its cash. Ceylon, he said, was in a unique position in which no other country in the history of its economic development had ever, been. He concluded that the result would be far-reaching if Ceylon forsook paddy cultivation.

Mr. A. A. Wickremesinghe thought any increase of taxation would be felt by the poor and particularly by the estates where the labourers depended entirely on imported rice. It was, he said, the low price of rice that saved the estates. He was opposed to the proposal.

Mr. Pararajasingham agreed with Mr. Wickremesinghe and said that it was dangerous to interfere with the natural law of consumption and production. He pointed out that the price of paddy in the North was between Re. 1-75 and Rs. 2/- and advocated better method of milling rice and adoption of modern methods and intensive cultivation in order to increase the yield.

Mr. Drieberg said that it was a dangerous experiment to raise the duty on rice and particularly so he thought as Ceylon was hoping to get India to consent to a reduction of import duty of Ceylon coconut. The only alternative was to subsidise paddy cultivation by allowing a bounty and this was also not practicable owing to the state of finances.

Rev. Fr. Wickremesinghe, in replying to some of the criticisms, said that if there was no increase of production of paddy it was due to the lack of irrigation facilities. As regards the contention that the increase of duty would affect the estates, he said that when the tea and rubber producers were making money during booms the paddy cultivator never did.

Mr. Pararajasingham thought that paddy cultivation was only a side line and Mr. Drieberg pointed out that it was not so in Fr. Wickremesinghe's district but it was the main industry.

Mr. De Silva thought that they were not justified in increasing the import duty in order to procure some benefit for a small section of the community and Fr. Wickremesinghe protested that his motion did not contemplate a tariff.

The Chairman remarked that it seemed to him that the reduced cultivation of paddy in the South might be an indication of the fact that the cultivators were taking to dry grain cultivation more permanently than in other parts of the Island. He thought that this was influenced by several economic factors and it might lead to the growing of cereal crops, cotton, maize, and legume in rotation. He further opined that dry cultivation has not made more advance and that the agricultural implements were very primitive.

Gate Mudaliyar Rajapakse opposed the proposal as it would affect the consumer who was poor. He recalled the fact that the proposal to fix a minimum price of paddy at Rs. 3/- per bushel during the rice crisis was abandoned by Government. He suggested Fr. Wickremesinghe to withdraw his motion, but the Chairman thought that it was not necessary as it was only a suggestion.

Udugama Dissawa said that if the import duty were to be raised the poor will suffer and opposed the motion. He further said that the Kandyan villager did not grow paddy as a business proposition but he did so because he considered it a disgrace to eat imported rice.

Mr. Haigh (Economic Botanist) said that he could not see how the paddy industry in Ceylon could derive any benefit by protection as Ceylon was not self-supporting in paddy.

The Chairman in concluding the debate said that the discussion had been a most interesting one and had presented the subject in a new light to several of them. He had no doubt that some of those present at the discussion would present Fr. Wickremesinghe's view to the Paddy Commission and that the Paddy Commission would carefully consider the same.

AGENDA ITEM 6

AGRICULTURAL INSTRUCTORS TO HELP AND INSTRUCT THE PEASANT CULTIVATOR

Rev. Fr. Wickremesinghe moved for discussion:

> "That the Agricultural Instructors stationed at the different agricultural centres be attached primarily to help and instruct the peasant cultivator rather than be wholly occupied with the Farm Station"

and in doing so he said that for many years there had been Agricultural Stations and Agricultural Instructors had been placed in charge of them but the cultivators were not taking any help or advice from them. Villagers looked upon the Agricultural Stations as very good things but they were short of finance to follow the methods adopted in these Stations. He therefore suggested that Instructors should go from village to village and instruct and advice villagers. He also thought that the Instructors similarly should visit schools and impart knowledge which the children could acquire and take back into their village and put into practice.

The Chairman, Messrs. Peiris, Wickremesinghe, Drieberg, Gate Mudaliyars Ramalingam and Rajapakse, Mr. Harbord, and Mr. Pararajasingham offered remarks.

The Chairman said that that was a very interesting motion and observed that Fr. Wickremesinghe was six months behind the times; the Agricultural Instructors and the Divisional Agricultural Officers had been given emphatic and explicit instructions on those lines suggested by Fr. Wickremesinghe, and he expected that these instructions should be carried out by all those officers. He said that the Instructor at Tissa in the Father's district had definite instructions about his work and he had been given manure and seed paddy for distribution to villagers, and he hoped that the Father in his parochial visitations would come across him before long.

Mr. Peiris (Divisional Agricultural Officer, South-Western) gave detailed account of the work done by himself and his Instructors in experiments with fertilizers, green manure, and seed selection.

Mr. Wickremesinghe enquired about the work done in connection with school gardens and the Chairman explained, and said, to achieve still better results closer co-operation between his and the Educational Department was wanted.

Mr. Drieberg said that the School Gardens Scheme was a success at the beginning and the Chairman jokingly remarked that that was about the time that Mr. Drieberg was responsible for the work.

Gate Mudaliyar Ramalingam testified to the good work done by the Instructors.

Gate Mudaliyar Rajapakse desired to grow new improved types of paddy suitable for Negombo and Messrs. Haigh, and Harbord promised to supply him with necessary information as regards suitable varieties such as B 13 or A Podiwi B 11, A 8 etc. The discussion closed.

AGENDA ITEM 7

THE UTILITY OF PADDY SEED STATIONS

Mudaliyar Muttutamby who was to have moved the following motion viz :

> "Means to increase the utility of Paddy Seed Stations and demonstration plots"

was absent and discussion of the motion was postponed.

The Chairman said that he intended visiting Mannar to see what could be done. He remarked that Mr. Muttutamby wanted a greater impression made on village cultivators and if Mr. Muttutamby would show the Department how it could be done, it would be of immense help to the Department.

Mr. Pararajasingham referred to the remarks made by the Chairman about the poor attendance and suggested the revival of holding of meetings in Colombo and Peradeniya alternatively. Mudaliyar Ramalingam said that for Jaffna members, Colombo was a more convenient place for meetings. The Chairman explained the difficulty of getting a suitable place for holding meetings in Colombo and asked the Secretary to see what could be done.

N. WICKRAMARATNE,
Secretary,
Food Products Committee.

VIEWS AND REVIEWS

SOIL EROSION IN CEYLON*

SOIL erosion is a world-wide problem and is increasingly attracting the attention of governments. A summary of present-day knowledge of the causes and effects of erosion and of preventive measures has recently been issued as Technical Communication No. 5. by the Imperial Bureau of Soil Science. It shows that little experimental work has been done and that data are required regarding the incidence of rainfall, and the amount of erosion caused thereby, the effectiveness of the various methods proposed for the conservation of water and soil and the extent to which soil characters are an important factor in determining erodibility. It points out that erosion forms the subject of publications from India, Ceylon, South Africa, New Zealand, Nyasaland, many parts of the United States, and several European countries. It is already the subject of legislation in various parts of the world and its urgency as a national problem in the United States of America is shown by the recent appropriation of 160,000 dollars (Rs. 450,000) by the Federal Government for research into its causes and means of prevention and into the conservation of rainfall by terracing and other means.

The problem in Ceylon has recently been investigated by a Committee representative of revenue, agricultural, irrigation, forestry, survey, and planting interests. The existence of serious soil erosion and the possible consequences thereof have been pointed out by scientific experts, agriculturists, Irrigation and Forest officers, since the time of Sir J. D. Hooker (1873). Largely as a result of statements made in the report of P. M. Lushington on Ceylon Forests Sessioual Paper XII of 1921) the present Committee was set up to consider the question of soil erosion in all its aspects.

The Committee made exhaustive enquiries into the state of affairs existent in Ceylon by visiting all the important planting districts and inspecting agricultural works, irrigation works, village settlements, and forest clearings. In each district it held enquiries at which planters, revenue officers, headmen, and representatives of the Irrigation, Public Works, and Railway Departments were invited to be present. It also met representatives of agents and proprietors of estates of all kinds. Its evidence was collected by the use of questionnaires to which written answers were obtained and by informal discussion at enquiries.

The present state of affairs in Ceylon is stated in some detail. Tea, rubber, and coconut estates, small holdings, village settlements, chena cultivation, and forest clearings are considered *seriatim* and the measures taken to combat soil erosion on each of these forms of cultivation are enumerated at length. The external evidence of erosion in the silting of estates and paddy fields, the damage to irrigation works, roads, and railways, the silting and flooding of rivers is also described.

* Report of the Committee on Soil Erosion. Celyon Sessional Paper III of 1931. Government Record Office, Colombo.

A section is devoted to an account of the attitude of agriculturists towards the question of soil erosion, as evinced by the evidence heard at enquiries. While it is to be regretted that several prominent agriculturists did not give the Committee the benefit of their experience, although more than one opportunity to do so was given to them, the majority of the planting community showed the greatest interest in the problem and discussed it fully and at length. It was found that on the whole the seriousness of the problem was realised, but that the realisation was by no means always translated into action. A variety of causes was responsible for this inaction. The prohibitive cost of adequate measures of soil conservation was urged by some; the lack of encouragement to spend money on works that did not show an immediate return in increased yields was given by others as a reason for the non-extension of preventive measures against erosion. Objection to the use of ground covers was perhaps the commonest cause of the inadequacy of existing measures of soil conservation. The vexed question of clean weeding was much discussed; the Committee put forward the suggestion that ground covers, were of the greatest importance in conserving soil and in preventing erosion; with that suggestion a majority of witnesses agreed, but contended that ground covers had disadvantages which outweighed any benefit that they might confer in the prevention of erosion. Upon further examination it was found all too commonly that the so-called disadvantages were founded largely on prejudice, and that the indictments against ground covers were difficult of proof.

The views of the Committee form the subject of a separate chapter. It is first laid down as an axiom that "soil erosion is caused primarily by the free movement of water on the surface of the ground". Accepting the truth of this axiom the report considers critically the measures of soil conservation enumerated in a previous chapter, and approves or condemns them by the efficiency with which they prevent the free movement of surface water. Judged by this standard, ground covers become of supreme importance and are considered by the Committee to provide the key to the solution of the problem of soil erosion. The objections that have been raised to the use of ground covers are discussed and are shown to be largely the result of prejudice or ignorance. Soil treatment is considered to be of importance if properly done, but shade, terraces, and leguminous hedges are only of limited value. Ideas of drainage systems stand in need of drastic revision, and drains should be regarded as a second line of defence against soil erosion rather than as a means of leading the water off the land by the shortest and quickest route. The tendency of recent years to flatten the gradient of drains should be encouraged, and the provision of silt-pits and locks and steps is essential if the drains are to fulfil their proper functions of holding up the water until a maximum amount may be absorbed and of removing from it any silt which other means of soil conservation may have allowed to be removed.

The present methods of treatment of new clearings leave much to be desired, and the Committee urges that more consideration shall be given to the crop in what is perhaps the most critical stage of its existence. The prevailng idea appears to be to establish a record time in which the crop may begin to yield, rather than to establish favourable conditions for growth from the beginning and to give the young plant a good start in life. There is no denying that commercial considerations must enter largely into estate practice, but a policy that considers immediate returns first and the health of the crop second is a short-sighted policy.

Educative propaganda is considered to be urgently required for the dissemination of modern ideas of soil conservation among small-holders and village cultivators; education in the possibilities of permanent rotation in dry areas is expected in time to reduce the area of land under chena cultivation, and to reduce thereby the damage done by this wasteful form of agriculture.

The recommendations of the Committee follow naturally from the views outlined above. The Committee considers that estate agriculture is responsible for a very large part of the erosion that is in progress in Ceylon, and that the first step that should be taken to combat the erosion should be the provision of ground cover. It recommends that education and propaganda should go hand in hand with research into methods of soil conservation; at the same time it holds that the safeguard against erosion that it has enumerated are so basically sound that they should be adopted at once and that their advantages will be confirmed by further investigation. It considers that education of small-holders and village cultivators should be the concern of the institutions devoted to agricultural research and above all of the revenue officers, whose co-operation is essential for success.

The question of legislation for the enforcement of measures of soil conservation received the serious attention of the Committee. Its first opinion on seeing the appalling wastage of soil that is in progress was that Government interference was called for; further consideration of ways and means and appreciation of the good work voluntarily done by agriculturists in recent years, led the Committee to re-consider its views and to divide the problem of soil erosion into two parts, those of external and internal damage. Without depreciating the significance of internal damage (i.e., damage to the land which is being eroded) the Committtee has decided that, until the possibilities of propaganda, persuasion and example have been exhausted, it is not desirable to recommend Government interference with private property; it considers, however, that the subject should be reviewed in five or seven years' time, and that if the improvements that are hoped for as a result of publication of the report have not taken place, compulsion by means of legislation should be considered.

The Committee considers that there is no justification for external damage (i.e., damage to property other than that on which the erosion is taking place). It recommends that steps should at once be taken to introduce legislation or to amend existing legislation so that those who damage others' property by the injudicious exploitation of their own land should be penalized, and that public departments should have power to insist on preventive measures where it is patent that external damage will occur as a result of proposed agricultural operations.

RUTHERFORD'S PLANTERS' NOTE BOOK*

RUTHERFORD'S Planters' Note Book, of which the 9th edition has recently appeared, needs no introduction to the planters of Ceylon. The first edition was published in 1887, and the book has been ever since the standard reference work on planting and allied matters.

The addition of an advertisement to the cover has distinctly detracted from the appearance of the 9th edition.

On turning the cover the absence of a preface is noticed, so that not even a general acknowledgment is made to the numerous authors whose publications have been freely used throughout the book.

A table of contents indicating the subjects of the chapters would be a useful addtion.

The first three chapters deal with land and survey, machinery, and buildings, and undoubtedly contain some of the most useful information in the book. These three chapters have been enlarged by 7, 14 and, 29 pages respectively, and, though much of the new matter is of undoubted value, there is a stage at which such material by increase of volume tends to lose its value as a reference work for the layman and assumes the character of a text-book for the expert.

The heading of the next chapter is Miscellaneous'' and it contains information on subjects as diverse as the removal of stains from clothing and the number of ''Quadraat Duim'' in a ''Quadraat Voeten''. It is an open question whether this chapter is needed. The general information can be found in a reference work such as a popular encyclopaedia, while the tables of weights and measures might perhaps be included in the chapter on land and survey, which already contains a number of such tables.

The chapter on labour contains an excellent and lucid summary of the system of recruiting now in force, the organisation of the Department of Indian Immigrant Labour and the Ceylon Labour Commission, and the general status of Indian labour on estates.

The chapter on tea lays itself open to a good deal of criticism, both as to balance and arrangement, and as to the selection of the matter inserted.

In dealing with the opening of tea clearings it is to be regretted that no mention is found of the possibility of contour planting, while the general question of soil erosion is largely ignored—the word erosion, in fact, does not even appear in the index! It is hoped that the 10th edition will contain extracts from the report of the Committee on Soil Erosion.

The statement on page 262 as to the toxic effect of grass must at least be considered as ''non-proven.''

In the sections which describe the operations of centring, it is noted that no mention is made of those methods of bringing young tea into bearing advocated by Mr. John Horsfall and others, although these methods have in the last few years achieved considerable publicity.

The section on manuring might perhaps be of more value if sample mixtures were quoted or, at all events, the quantities of nitrogen, phosphoric acid, and potash found in representative mixtures.

Rutherford's Planters' Note Book, 9th Edition. The Times of Ceylon Co. Ltd., Colombo, 1931. Rs. 20/- (s. 30/-).

The section of green manuring is one of the most disappointing in the book. If "Buildings" and "Medical" are worth 103 pages each, surely green manuring is worth more than 2 pages ? Apart from its inadequacy, this section contains some questionable statements. Both *Gliricidia maculata* and *Indigofera endecaphylla* (which is misspelt " endecopilla") are included in a paragraph headed *Shrubs*. This same paragraph of two and a half lines contains three spelling mistakes and three cases of the wrong use of capitals.

The paragraph on creepers mentions *Vigna oligosperma* and *Vigna hosei*, though these are one and the same plant, and its correct name is *Dolichos hosei*.

After the general article which is found at the beginning of the chapter a number of publications, or extracts from publications, of the Ceylon Department of Agriculture are inserted. It is obviously impossible to include publications dealing with every phase of tea planting and it is suggested that a preferable method would have been to enlist the services of an expert to contribute a concise article on each principal subject (as has been done in the case of rubber diseases). The officers of the Tea Research Institute suggest themselves in this connection—but the existence of the Tea Research Institute is not even mentioned in the book.

Moreover the publications chosen for inclusion do not always seem the most suitable. Thus, in dealing with Shot-hole borer, the whole or portions of publications issued in 1903 and 1918 are included but no mention is made of Bulletins 56, 72, or 78, published in 1922, 1925, and 1926 respectively. Again all the publications included deal with insect pests; diseases are somewhat inadequately dealt with in two pages, which incidentally contain further misspellings.

Manufacture is lucidly and concisely dealt with in a single article—the name of the author is not given.

The chapter on rubber starts with an interesting general article by Mr. E. C. Villers which is followed by extracts from Garnier's *Ceylon Rubber Planters' Manual*. In this chapter it is thought that the question of cover crops is not given the prominence it deserves. Only one ground cover plant is mentioned.

The inclusion of Mr. Denham Till's lecture on methods of opening rubber clearings is a wise step.

The wisdom of the selection of Department of Agriculture publications in this chapter may again be questioned. Bulletins 55, 68, and 77 all deal (under different titles) with the correlation between yield and various vegetative characters in a certain plot of rubber on the Experiment Station, Peradeniya. Extracts from Bulletin 68 are first given, then, after plunging into a number of other subjects, extracts from Bulletin 55 (the earliest one) are given twenty pages later. Bulletin 77 (the latest) is not mentioned at all. The other publications quoted are in some cases very old and more up-to-date literature on the same questions exists in plenty.

The section on manufacture starts with *The Occurrence of Bubbles in Sheet Rubber* followed by other extracts from publications dealing with problems of manufacture. One would have thought that a general description of manufacture would be a more appropriate beginning, but this only comes ten pages later when extracts from O'Brien's *Preparation of Plantation Rubber* are given. Practically all the information on rubber manufacture necessary for a book of this kind could have been obtained from this booklet and that the inclusion of Mr. L. M. W. Wilkin's article on smoked sheet which, though an excellent article, obviously goes back to the early days of sheet, was scarcely necessary.

The tables showing the percentage of profit on a rubber property at varying capital and yields will probably be hurriedly passed over in 1931.

The article on budding contains much interesting and useful information, though one or two statements call for some comment. Allusion is made to the choice between "seedlings and stumps" as stocks. Apart from the fact that the "Stump" so alluded to is a seedling, in practice a stumped seedling is practically never used. Again a geneticist would probably not accept as complete the statement that uneven results are obtained from planting seed of one tree because of "the varied pollination that takes place"; Self-fertilisation would not eliminate the mixed genetic heritage of the tree. Rejuvenation is dealt with, but complete replanting is not mentioned, though this is now usually considered the best course. The name of the author of this section is also not given.

Mr. Murray's comprehensive survey of rubber diseases is of the length and character desired for inclusion in a work of this kind.

The chapter on coconuts is perhaps rather better balanced than those on tea and rubber—possibly because a less bewildering array of technical publications exists.

The chapter entitled "Cultivation and Manuring", contains much valuable information. Being of a general character it is suggested that it might be better inserted *before* the chapters dealing with particular crops.

The next chapter is headed "Planting Diseases and Pests". As these have already been dealt with under the crops concerned one wonders what the contents of this chapter is to be. Actually the chapter contains an account of one pest only (termites), and no diseases; the remainder of the chapter is occupied with plant pest and disease legislation. The latter is a most necessary inclusion but if a chapter under this heading is to be included, it would possibly be better to have relegated *all* accounts and publications dealing with pests and disease to this chapter. Alternatively all diseases and pests might be included under the chapters on the crops to which they chiefly apply and the legislative portion might be transferred to the later chapter on legal matters.

The chapter on medical matters is most comprehensive, but here again the particular precedes the general: the chapter starts with a description of hookworm, while some pages later are found sections entitled *"Simple Rules of Health"*, and *"How to Avoid Diseases"*.

The chapters on the diseases of animals, electricity, and book-keeping all gain in conciseness, lucidity, and value from a lack of multiplicity of authors.

Rutherford's Planters' Note Book has been of unquestionable value to generations of planters but it is certain that its value could be greatly enhanced and, at the same time, its bulk considerably reduced by better balance and arrangement, by more specially written articles by experts, and by a more judicious selection of literature to be included.—T.H.H.

AN ECONOMIC VIEW OF RUBBER PLANTING*

THIS is an unpretentious booklet written by one who apologises for not being a planter, but a banker. The author seems to have travelled through rubber-producing lands and to have made and recorded first-hand observations. The book is interesting especially because of the notes upon matters connected with the rubber industry in some countries that may not have been realised by those resident in another. Some of these notes are of a nature that will especially interest those concerned with rubber in Ceylon. For this reason it is intended here to give a synoptic review of the book not with the idea of obviating one from the necessity of purchasing it, but rather to whet the appetite to read more.

The author possesses a vein of optimism as to the future of the rubber-growing industry such as is certainly not shared by all, and he still thinks "that the industry has a very bright future." He blames the "Stevenson Scheme" for much of the present depression. "Artificially maintained prices induced the native of Sumatra and Borneo to plant new gardens. Had not the price been raised in such an abnormal way, the native would never have planted over 1,000,000 acres in a few years, as rapid extensions require capital and native cultivation always proceeds slowly in normal circumstances."

"The surface under rubber in the Dutch East Indies should therefore now reach nearly 1,200,000 ha. (3,000,000 acres) against 500,000 ha. in 1923, i.e., an increase of about 15% in five years—thanks mostly, it may be said to the "Stevenson Scheme".

A table is given of the acreages planted by the leading companies in Malaya :

	Acres
"Dunlop Rubber Plantations, Ltd.	85,000
S. I. P. E. F. (F. M. S. Rubber Co., and other subsidiaries)	80,000
Société Financiére des Caoutchoucs (several companies, but under the same general manager)	28,000
Malayan American Plantations, Ltd.	24,000
Malacca Rubber Plantations, Ltd.	22,000
Anglo-Java Rubber & Produce Co. Ltd. ...	23,000
United Sua Betong Rubber Co., Ltd.	22,000
East Asiatic Rubber Co., Ltd.	23,000
Penang Rubber Co., Ltd.	16,000
London Asiatic Rubber & Produce Co., Ltd ...	11,000
Linggi Plantations, Ltd.	10,000
Straits Rubber Co., Ltd.	10,000
	354,000

"In Malaya, generally speaking large companies own a fair number of average-sized estates (from 2,000 to 3,000 acres) under the supervision of a general manager and visiting inspectors. There are very few large estates in one block, an exception being the Dunlop Plantations, Ltd., which are now planting about 12,000 acres in one block. Almost all these companies have their Head Office and Boards of Directors in London".

* "An Economic View of Rubber Planting" by R. Soliva. Kelly & Walsh, Limited, Singapore. 2$. 50 cts.

"The organization of small estates of a few thousand acres is generally this: First of all, many are not quite independent, but are more or less under the control of agency firms which keep their accounts, sell their rubber in Singapore or London and often supply them with a manager and a visiting agent. The agents are frequently interested in the estates holding more or less important blocks of shares and having a seat on the Board."

"In Java there is a large number of small companies" and "Sumatra is the land of the largest rubber companies in the world".

The areas of the leading Dutch East Indies companies are thus given:

	Hectares
"Société Financiére and subsidiaries (Soengei Liput Cult. Mij. Asahan Cult. Mij., Batangara Cult. Mij., etc.)	26,000
Rubber Cultuur Mij. Amsterdam (R. C. M. A.) ...	24,000
The Hollandsch Amerikansche Plantage Mij. (H.A.P.M.) and associated companies, a subsidiary to the General Rubber Co.	23,500
Harrisons & Crossfield (United Serdang, Central Sumatra Rubber Estates, Etc.)	19,500
Deli Batavia Rubber Mij.	8,000
The Goodyear Orient Co. (a subsidiary to the Gooodyear Rubber Company)	8,500
Deli Mij.	5,500
	115,000

1 hectare = 2½ acres."

In Ceylon "no large companies are to be found possessing 5,000 or 10,000 acres as in Malaya and the Dutch East Indies. But a few groups control rather a large number of small estates totalling several thousands of acres".

"It seems to be the general opinion of European planters that low-lying lands are not suitable for growing rubber. Yet in 1929 in the F.M.S. the average production of native estates was estimated at 500 lb. against 400 lb. for European estates. I personally visited a large number of native gardens and was much surprised at the high yield of their trees, which undoubtedly confirms the accuracy of the statistics.

It is however difficult to conclude anything definite on the matter for the two following reasons:

1. Native estates are generally planted with 200 and even 250 trees per acre, while European ones have generally from 80 to 100 and are certainly under-planted.
2. Native estates allow secondary growth between the trees, and generally lie on very flat land; consequently they do not suffer much from erosion. On the contrary European estates situate on hilly land, have lost most of their top soil, thanks to "clean weeding".

"It is very difficult to ascertain the area under budded rubber, for there are numerous estates which have budded a few scores of acres, and no statistics whatsoever are available.

I know personally of about 30/40,000 acres which will be budded by the end of 1930.

If one supposes there are some further 30/40,000 acres budded on large plantations and on small extensions of middle-size estates, one would estimate the budded area at some 70,000 acres (about 30,000 hectares) corresponding to about 5% of rubber under European or American ownership in British Malaya".

"It is noteworthy that in this respect the Dunlop Plantations, Ltd. are far in advance compared with other companies. They appear to have been among the first to start budding on a large scale in Malaya, under the supervision of a Dutchman, Dr. Cramer, who formerly was one of the Heads of the Agricultural Department in Buitenzorg.

One of the most interesting facts of the opening of the Dunlop Plantations, is that they have bud-grafted some 6,000/7,000 acres of trees, some of which were 2½ years old. I could see that the results were very satisfactory and I noticed the same thing at the Pasak Rubber Co., which is now bud-grafting about 2,000 acres from one to three years old."

"Practically all the estates turn out smoked sheet or crepe, as usual, with the exception of some estates which use new processes. One of these is the "Sprayed Rubber Process" of the Malayan American Plantations (a subsidiary to the General Rubber Co., of New York), used by the H.A.P.M. and the Anglo-Dutch Plantations of Java, in the D.E.I.

The other which appears to be the more interesting is the concentration of latex by the centrifugal process in use on the Dunlop Plantations, Ltd.

Latex is thus concentrated to 60% rubber content instead of 30 to 35% in its natural condition and shipped to Europe in tins or barrels. All the latex however cannot be concentrated this way and in fact, about 10% remains which has to be turned into crepe. What makes the process of special interest is that the buyers in London pay for concentrated latex, 40 to 50 per cent. more per lb. dry, than for standard crepe, owing to the saving they realise in its use."

Some interesting notes are given upon the health conditions of the labour force on rubber estates.

"The opening of new estates has always been very unhealthy, and Malaya has been no exception to the rule; but the matter has been taken in hand very efficiently by the Government with the help of the planters, and results may be considered very satisfactory.

About 1911/1912 the death rate on estates varied from 4% to 6%. In 1927 it was 3%, and in 1928 2·9%, which means a decrease of nearly one-half. These last figures are very near the averages for towns or rice-fields.

How were these results obtained ?

Although coolies suffer from many diseases such as hookworm, dysentery, etc., the most dreadful one is malaria, and this has been fought by every possible means.

The disease is carried from one cooly to another by the anopheles mosquito and there are two ways of fighting it: isolation of sick coolies or destruction of carriers.

Conversely to what has been done in the Dutch East Indies, efforts have been mostly directed towards the destruction of mosquitoes rather than to the isolation of sick coolies.

A thorough investigation of the habits of anopheles was conducted from 1900 to 1910 and revealed three main kinds of harmful species in Malaya: *A. ludlowi, A. umbrosus,* and *A. maculatus.*

Though the matter has been much discussed for long in Malaya, it may be found of interest to say a few words about it.

A. ludlowi lives in marshes and swamps and in brackish water, often near the sea. It is generally easily controlled when the soil is dried by open drains. As however European estates are very seldom located on the alluvial coast, they are rarely affected by this mosquito, but rather by *A. umbrosus* and *A. maculatus.*

The former lives in the jungle in the shade. It generally disappears when the jungle is cleared and open drains are dug. But when *A. umbrosus* is controlled, then appears *A. maculatus* which lives in running water exposed to the sun. It has been very difficult to eradicate it; yet estates have succeeded in controlling *A. maculatus* through sub-soil drainage or oiling; but they are expensive methods.

Owing to the high cost of anti-malarial works against *A. maculatus*, the tendency is now to concentrate European bungalows and cooly lines within a circle having a radius of 400/500 metres which is extensively drained and oiled and to do nothing or very little in the other parts of the estate. This method is being adopted by the Dunlop Plantations, Ltd., for their new openings."

The author has a keen appreciation of the value of scientific research and bud-grafting. Speaking of the rubber in the Dutch East Indies he says:

"A typical character of the large estates, with one exception, is the importance devoted to research departments which employ large staffs, and work in very close connection with the AVROS., the well-known Planters' Association of the East Coast of Sumatra (Algemeene Vereeniging van Rubber Planters ter Oostkust van Sumatra)."

"One cannot too much emphasise, in my opinion, the leading rôle played by these research departments, and nothing is more demonstrative of their usefulness than the awkward position of the companies who have been planting with ordinary material for the last few years and whose plantations will be almost valueless in five or ten years, unless they bud immediately their trees, even if they are three or four years old".

"But the most important fact as regards new planting is the budding of rubber trees which is now universally considered in Sumatra as having left the experimental stage. Most estates have already budded their new openings for several years, without inter-planting them with seedlings, as was done heretofore as a measure of safety in case of failure of budding. Besides, some companies are now tapping somewhat large budded areas (probably several thousands of hectares) and the results appear so far to meet expectation."

"It is at present difficult to ascertain the practical results of bud-grafting, as the oldest fields planted with buddings came under tapping only six months or one year ago. Anyhow it may be of interest to know the following facts:

A few hundred hectares, six years old belonging to the RCMA (Rubber Culture Mij. Amsterdam) has yielded about 900kg. (810 lb.); 20 ha. of the HAPM (the Hollandsch Amerikansche Plantage Mij.) planted nine years ago is said to yield 900/1,000 kg. per ha; a small area of the same company covering only 3 ha., and seven years old, is said to give 1,400 kg. per ha.

Further, I will recall, it is now generally admitted that the first clones of AVROS numbers 49 and 50, will give 4 to 4½ kg. (8 to 10 lb.) and the newly-proved clones such as AVROS No. 152, Bodjong Datar Nos. 5 and 10, Prang Besar, Tjirandji, will yield from 8 to 10 kg. (15 to 20 lb.) In fact the aim of some large companies like the RCMA and the HAPM, is to plant with trees giving 8 to 9 kg. (17 to 20 lb.) per tree, corresponding with 300 trees per ha. to a theoretical yield of over 2,500 kg. per hectare.

Though such yields will not be practically reached, yet productions of 1,000 kg. or even 1,200 kg. per ha. (900 or 1,100 lb.) appear quite reasonable, as ordinary trees giving about 2 to 2½ kg. (4 to 5 lb.) yield on a good estate 450/500 kg. per hectare, with 200/250 trees per hectare."

"Very interesting efforts are made, on one side, to improve the preparation of rubber and ship a produce easier to work than sheets, and, on the other, to reduce the cost of milling.

The HAPM have established a very large central factory which can turn out yearly 18,000 tons of liquid latex and sprayed rubber, coagulated by heat instead of the usual acid.

The RCMA is trying also to ship a liquid produce called "revertex" which is latex concentrated by evaporation up to 70-75% of dry rubber.

It is very likely that many other improvements will be introduced in the future, for companies are devoting more and more attention and money to mills in their provisions for new plantations. I should add that this will be one of the most efficient weapons against native and Chinese producers who (as in the case of sugar and palm oil) will never be able to compete in the scientific field."

With regard to average yields in the various producing countries the author's comparison is not so full and certain as we should like. He complains of the difficulty of estimating, being due to variation in restriction assessments in the different countries during the "Stevenson Scheme". The average production for Malaya in 1929 is worked out at 410 lb. per acre against only 356 in Ceylon, although the three previous years' averages are given as 280 lb. and 270 lb. respectively.

The average yield per acre for Java in 1929 is given as 393 lb. and for Sumatra 381 lb. and average for the three previous years works out at 359 lb. and 355 lb. These figures are certainly very different from the beliefs held by some.

It is difficult to understand why in the comparison of costs of production in Sumatra and Malaya in the table on page 81 income-tax should be added in each case, but on page 104 in the comparison between Malaya and Ceylon income-tax is omitted from the Malayan expenditure and the cost of production reduced accordingly.

The author's method of treating costings is somewhat algebraical. Although the formulae are readily understandable when one follows their deduction yet their employment in synoptical tables involves considerable back reference to see what the symbols do mean.

We do not however wish to depreciate the value we have found in this publication. We advise all those interested in rubber to procure the book—and read it.

LABOUR PROBLEMS OF CEYLON*

THIS small and inexpensive book, printed and published by Frewin & Co., Colombo, will be found of value and interest to all employers of labour who have the welfare of the labouring classes at heart. In it the author has endeavoured to analyse the present position as it relates to both estate labour—and non-estate labour. With regard to estate labour, of which by far the greater and more effective part is composed of Indian immigrant labourers and their descendants, emphasis is given to the fact that "living in" and working conditions have greatly improved in recent years, but that general conditions for local labour do not compare so favourably.

The many aspects of labour questions have been ably emphasised in this book, a perusal of which makes one realise the complexity of the labour problem in Ceylon, and the great necessity for serious study in the elucidation of these problems.—G.H.

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* *Labour Problems of Ceylon,* by S. E. N. Nicholas. Frewin & Co., Colombo Price Re. 1-50.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 30th APRIL, 1931

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st 1931	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	240	67	41	160	24	15
	Foot-and-mouth disease	470	254	414	3	52	1
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	2 *	...	...	...	...	2
	Piroplasmosis	...	...	...	...	...	...
Colombo Municipality	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	211	18	181	8	22	...
	Anthrax (Sheep & Goats)	11 †	2	...	11	...	...
	Rabies (Dogs)	2	...	...	...	...	2
	Haemorrhagic Septicaemia	...	...	...	...	...	...
	Black Quarter	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	
Cattle Quarantine Station	Rinderpest	.	...	...	...	...	...
	Foot-and-mouth disease	...	..	...	...	...	...
	Anthrax (Sheep & Goats)	88	9	...	88	...	...
Central	Rinderpest	...	..	..	..	...	...
	Foot-and-mouth disease	14	...	14	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	6	...	...	..	...	6
Southern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1039	7	986	5	48	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	..	...	...	...
Northern	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						
	Black Quarter						
	Rabies (Dogs)						
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...		...	...
	Anthrax	...	...	...	...	...	...
	Surra	5	5	...	5	...	...
North-Western	Rinderpest	6537	2582	74	5689	60	714
	Foot-and-mouth disease	...	...	...	...	. .	...
	Anthrax	...	...	...	..	...	...
	Pleuro-Pneumonia (in Goats)	...	...	...	...	...	...
North-Central	Rinderpest	2421	522	327	1854	171	69
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1	...	1	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...		...	...	...	...
Sabaragamuwa	Rinderpest	...	...	..	...	...	...
	Foot-and-mouth disease	41	41	17	...	24	...
	Anthrax	..	...	...	...	...	...
	Haemorrhagic Septicaemia	18	13	...	18	...	...
	Piroplasmosis	1	...	1	...	...	...
	Rabies (Dogs)	1	...	...	...	...	1

* 1 case in a cow. † 2 cases amongst cattle.

G. V. S. Office,
Colombo, 8th May, 1931.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT

APRIL, 1931

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches
Colombo -	88·6	+0·5	75·8	+0·3	74	93	7·0	9·40	22	+ 0·53
Puttalam -	89·4	+0·3	76·1	+0·9	75	91	4·6	5·17	9	- 0·33
Mannar -	91·1	−1·0	77·5	−0·2	74	89	4·0	3·66	9	+ 0·75
Jaffna -	89·2	−0·1	80·8	+0·3	76	85	3·8	2·85	7	+ 0·82
Trincomalee -	89·2	−0·3	77·9	+0·6	74	89	3·6	2·35	6	+ 0·24
Batticaloa -	88·5	+0·2	76·3	+0·4	78	95	5·6	3·49	4	+ 1·56
Hambantota -	88·0	+0·7	76·2	+1·5	74	91	4·0	11·91	12	+ 8·58
Galle -	86·9	+0·9	76·9	+0·5	78	91	5·7	11·43	15	+ 1·75
Ratnapura -	92·1	+2·4	74·2	0	78	93	4·9	14·95	24	+ 2·63
A'pura -	92·6	+0·9	75·1	+0·6	66	95	6·2	10·35	12	+ 3·59
Kurunegala -	92·7	+0·7	75·0	+0·8	68	93	6·7	11·00	17	+ 1·09
Kandy -	88·4	+1·4	70·4	+0·6	72	95	6·2	8·13	22	+ 1·31
Badulla -	84·1	+0·1	67·2	+1·6	80	97	5·8	14·08	23	+ 6·69
Diyatalawa -	78·3	+0·9	61·7	+1·6	76	92	6·2	17·69	23	+11·92
Hakgala -	74·5	−0·7	56·6	+2·7	80	94	5·6	11·78	27	+ 4·52
N'Eliya -	71·4	+0·1	50·5	+2·6	78	97	6·6	11·35	24	+ 5·72

Thunderstorm activity was exceedingly well marked in April and several cases of damage by lightning occurred. The accompanying rain was above average over the greater part of the Island, though deficits preponderated in the W.P., the N.W.P., and the western part of Sab.

The rainfall was in excess over most of the main hill country, and particularly so along its southern limits, the chief contribution to this being on the 14th, when both the Hospital and the Railway Station at Haputale recorded over 9 inches, while over 8 inches was recorded at each of West Haputale, Blackwood and Diyatalawa P.W.D., while further north Rangala and Kobonella both reported over 7 inches. Falls of between 5 and 7 inches were far too numerous on that day to refer to individually, though mention may be made of heavy rain further south on the 29th, when Mawarella had 7 inches and Morawaka 6½.

The highest totals for the month were 35·4 inches at West Haputale and 30·6 at Blackwood. West Haputale's figure is a record for any one month at that station, while at most places in the neighbourhood this month's total is the highest on record for the month of April. In the case of Diyatalawa, where figures for 31 years are available, it is 67% in excess of the next wettest April.

All stations throughout Ceylon reported some rain, and very few reported less than a couple of inches.

A squall at Colombo on the 27th was noticeable, both on account of a velocity of 69 miles per hour recorded at the Pilot Station, and because of its extreme localisation. In the Fort, immediately south of the harbour, the velocity was much weaker, while at the Observatory it was under 30 miles per hour.

Temperatures and Humidities were both rather above average, while, despite the rain being generally in excess, the same was true of the duration of sunshine.

Indications for the ensuing season are not very definite. The slight correlation afforded by the thunderstorm activity of April suggests less rather than more, than the usual rainfall at western up-country stations for May-September inclusive.

A. J. BAMFORD,
Superintendent, Observatory.